DECEMBER 1951

RADIO-ELECTRONICS

LATEST IN TELEVISION • SERVICING • AUDIO

HUGO GERNSBACK, *Editor*

LIGHT-SENSITIVE
ELECTRONIC BEAST

SEE ELECTRONICS

30¢
U.S. and
CANADA

In this issue: **Measuring Distortion • Scotsman's Super • New Life for Old Radios**

You get *all five*

...with RCA Batteries

1. Radio-Engineered Quality

(for extra listening hours)

2. Radio Trade Distribution

3. Top Brand Acceptance

4. Greatest Array of Selling Aids

5. Completely Rounded Line

What is "radio-engineered quality"?

It's the *extra* performance you get from batteries that are *specifically designed for radio use* and built to exacting quality standards of RCA's tube and battery engineers.

For your customers, "Radio-Engineered Quality" means *extra listening hours, greater satisfaction.*

For you, it means *more repeat sales, greater profits.*

You get *plenty of other benefits,* too, when you stock and sell the RCA line . . .

You get Radio Trade Distribution . . . RCA Battery distribution steers customers back to radio dealers and servicemen . . . away from the non-radio outlets. Repeat sales come back to *you,* again and again.

You get Top Brand Acceptance . . . a *pre-sold* name that's known to every radio and TV set owner in America, a *name that sells itself.*

You get the greatest array of Selling Aids . . . signs, displays, merchandisers, servicing aids . . . all helping you to make sales right at the point of purchase.

You get a Completely Rounded Line . . . for example, there are seven batteries designed to meet most of your demand. The complete line provides a type for almost every portable and farm radio need.

• • •

Call your local RCA Battery Distributor now. Get full details on how you too can join in the *radio-trade* switch to RCA *Radio-Engineered* batteries. Hundreds of other radio dealers and servicemen are finding they are the *batteries geared to their radio trade.* You will too. So call your RCA Battery Distributor. Get lined up for more battery sales, better profits . . . *today.*

RADIO CORPORATION of AMERICA

RADIO BATTERIES **HARRISON, N. J.**

RADIO-ELECTRONICS

formerly RADIO-CRAFT

MEMBER
AUDIT BUREAU OF CIRCULATIONS

Incorporating
SHORT WAVE CRAFT* TELEVISION NEWS*
RADIO & TELEVISION
*Trademark registered U. S. Patent Office

CONTENTS—DECEMBER, 1951

ON THE COVER: Squee, the electronic squirrel, prepares to follow a lighted flashlamp held by one of his builders, Jack Koff.
Ektachrome original by Avery Slack

WATCH FOR THE 5TH ANNUAL TELEVISION NUMBER NEXT MONTH

December, 1951 RADIO-ELECTRONICS Vol. XXIII, No. 3

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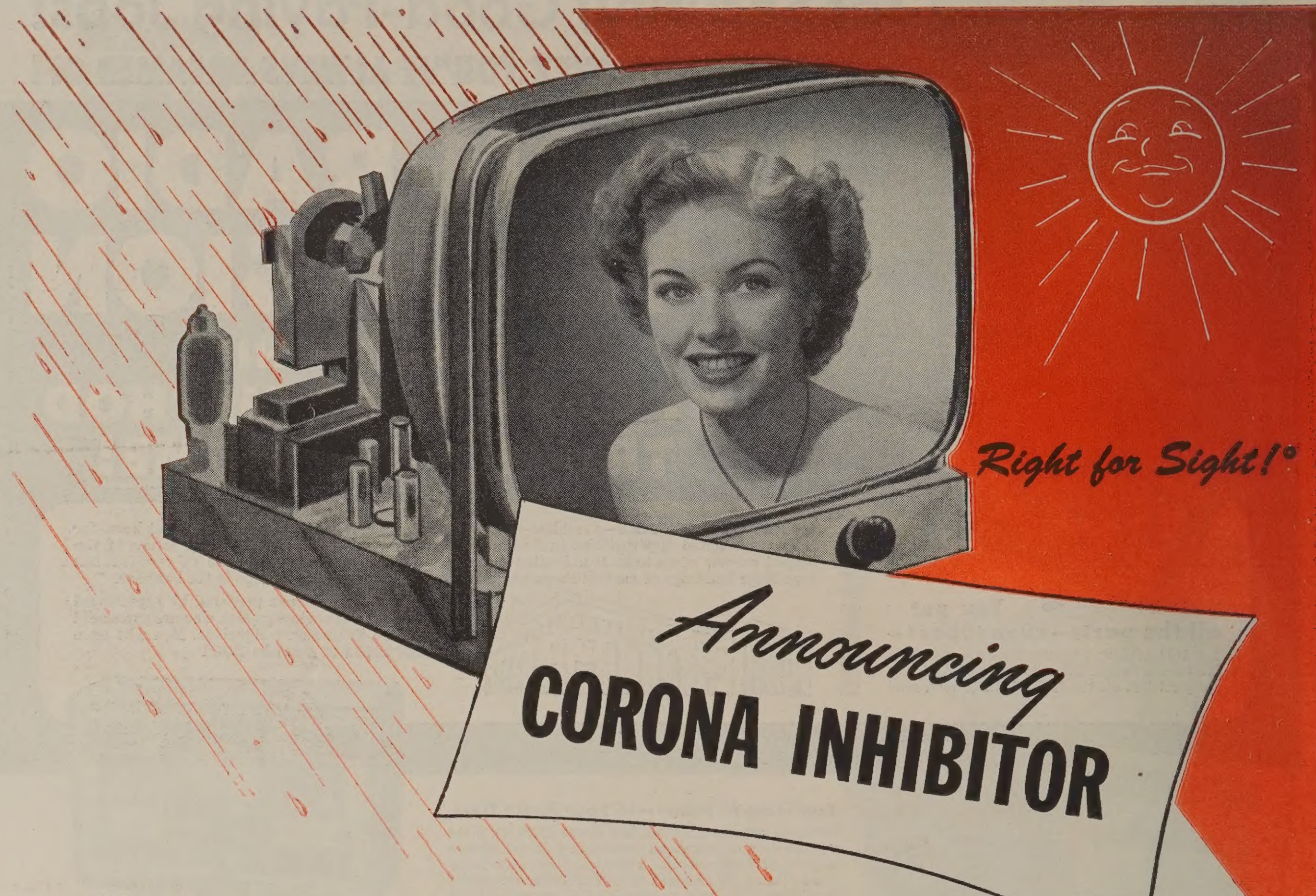

Now, for the first time, you can get television picture tubes that are *not affected by atmospheric conditions.* Ordinary picture tubes may lose as much as one-tenth of their brightness on humid or rainy days, but RAYTHEON made Tubes with CORONA INHIBITOR are 100% efficient *rain* or *shine.*

This amazing new weather-proofing is so effective, that even when tested with a water spray on the high voltage contact, RAYTHEON Tubes with the CORONA INHIBITOR showed *no loss of brightness* due to arcing around the high-voltage connection.

Ask your RAYTHEON Tube Distributor for Raytheon Picture Tubes with CORONA INHIBITOR. Your customers will like them . . . and so will you.

the new RAYTHEON development that keeps

TELEVISION PICTURE TUBES

at peak performance

Rain or Shine

RAYTHEON®

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division

Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

RADIO AND TELEVISION RECEIVING TUBES, PICTURE TUBES, SPECIAL PURPOSE TUBES, SUBMINIATURE TUBES, MICROWAVE TUBES

They're headed for new frontiers

At the Laboratories' school for communications development training, the curriculum includes electronics, oscillations and waves, switching and transmission. Each subject is directly keyed to the latest fields of telephone research.

Each year the Bell System selects hundreds of engineering graduates from technical schools, to find the answers to communications problems through the application of science and technology. A specifically qualified group joins Bell Laboratories to develop *tomorrow's* telephone system — also, in the present emergency, more powerful electronic devices for the armed services.

They come — thanks to the competence of our nation's educators—with an excellent grounding in fundamentals. To equip them still further, the Laboratories operate a school at graduate level for advanced communications.

The new men receive an intensive course in the latest theory and techniques. At the same time they take their places as members of the Technical Staff doing responsible work which, with their classroom instruction, reveals where they can make the most of their aptitudes.

● More than ever America's future must depend on men and women who are trained to think far ahead in technology whether for tomorrow's telephones or national defense. By helping them, Bell Telephone Laboratories help make America's telephone system the world's best, help the armed forces keep our country strong.

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Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.

AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES — BELL SYSTEM

NOW . . . GET EVERYTHING YOU NEED TO LEARN AND MASTER

TELEVISION

RADIO-ELECTRONICS ...AT HOME!

Use REAL commercial-type equipment to get practical experience

Your future deserves and needs every advantage you can give it! That's why you owe it to yourself to find out about one of the most COMPLETE, practical and effective ways now available to prepare AT HOME for America's billion dollar opportunity field of TELEVISION-RADIO-ELECTRONICS. See how you may get and keep the same type of basic training equipment used in one of the nation's finest training laboratories . . . how you may get real STARTING HELP toward a good job or your own business in Television-Radio-Electronics. Mail the coupon today for complete facts — including 89 ways to earn money in this thrilling, newer field.

ABOVE: Build and keep a real 16 INCH commercial TV receiver. Optional after completing regular training at moderate added cost.

Here's the REAL THING!

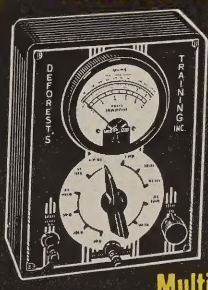
SET UP YOUR OWN HOME LABORATORY

D.T.I., ALONE, INCLUDES BOTH MOVIES and HOME LABORATORY
In addition to easy-to-read lessons, you get the use of HOME MOVIES — an outstanding training advantage — plus 16 big shipments of Electronic parts. Perform over 300 fascinating experiments for practical experience. Build and keep real commercial-type test equipment shown at right

MODERN LABORATORIES
If you prefer, get all your preparation in our new Chicago Training Laboratories—one of the finest of its kind. Ample instructors, modern equipment. Write for details!

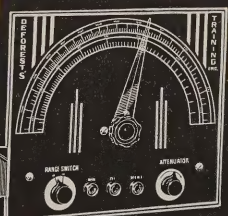
Get BOTH of these information packed publications FREE!

MILITARY SERVICE!
If you're subject to military service, the information we have for you should prove very helpful. Mail coupon today.



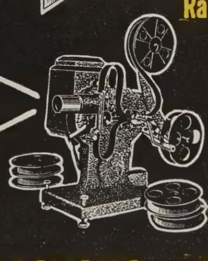
Multimeter

Oscilloscope



R-F Signal Generator

6-Tube Radio



HOME MOVIES

ACT NOW! MAIL COUPON TODAY!

DE FOREST'S TRAINING, INC., DEPT. RE-12-H
2533 N. Ashland Ave., Chicago 14, Ill.

Without obligation, I would like your Opportunity News Bulletin showing "89 Ways to Earn Money in Television-Radio-Electronics"; also, the folder showing how I may prepare to get started in this thrilling field.

Name________________ Age____

Address________________ Apt.____

City________________ Zone____ State________

De FOREST'S TRAINING, INC.
CHICAGO 14, ILLINOIS
A De VRY INSTITUTION

LONG-RANGE RADAR installations on the Arctic frontier network may now be manned either by Canadian or United States operators, reports the Air Force. Previously, Canada's law required its radio and radar operators to be British subjects, but an Order-in-Council by Canada's Department of Defense has cleared the way for joint operation of the long-range warning network by nationals of either country.

The new installations, built by the General Electric Company, require 400 men to operate the multiple positions on a 24-hour basis at each location.

460-MC TWO-WAY RADIO communication has been inaugurated by the City of Miami in its police radio system.

Miami was also the first to initiate police operations on the 160-mc band, which is the currently accepted police communication band in many parts of the country. From the first units in the 160-mc band, the City of Miami police system has been developed until today it includes 6 two-way radio base stations and 270 two-way mobile radios. Motorola developed and built both systems for the City of Miami.

EXPERIMENTAL U.H.F. TV station is being built by Sylvania Electric Products, Inc., at Emporium, Pa. The application to transmit monoscope and test patterns on 870 to 890 megacycles was granted by the Federal Communications Commission on October 2.

SECRET TV SYSTEM will be used by the Navy in its new giant carrier, the *Forrestal*. The flush deck of the carrier, without the superstructure of present-day carriers, will enable her to handle many types of planes, including atomic bombers. The new television system is said to be designed to help the planes to land.

ULTRASOUND may aid in the preparation of new and better vaccines against bacteria and viruses, according to Dr. Nelson Newton, of the Battelle Memorial Institute. Specimens of tobacco mosaic virus exposed to ultra sound for 3⅓ minutes lost 95% of its infectivity. It is believed that the rod-shaped viruses are broken up by the sonic waves.

Dr. Newton has been experimenting with ultrasonic waves at the extremely high frequency of 7 megacycles per second. He reports further that another series of tests with reduced intensity and varied exposure times to the radiation produced, among other effects, an increased infectivity of "aged," or old, viruses. This, he suggests, might be applied to reactivating and possibly extending the period of usefulness of aged vaccines.

NEW RADIO-CONTROLLED robot jet guided missile, the B-61 Matador, has been developed for the Air Force by the Glenn L. Martin Co. Although intended as a weapon of offense, the bomber cannot exceed a horizon-to-horizon operating radius due to the nature of the high-frequency radio waves used in controlling its flight.

A piloted mother plane equipped with an intricate electronic and radar system is used in guiding the pilotless plane to its tactical destination. A series of spaced relay control stations may also be used in lieu of the piloted mother plane for control purposes over long distances.

Radar signals from the controlling stations are used to keep track of the Matador's flight course and its exact location.

THE LOUDEST SIGNAL on the world dial is the goal sought by George Q. Herrick, chief of the facilities of the Voice of America. A $4,188,000 appropriation by Congress has cleared the way for construction at six locations of ten super-power curtain antennas which will have a width of 755 feet between towers. The towers supporting the curtain will be 290 feet tall on one side and 250 feet on the other.

Up till now, the executive reported, the long transmission distances involved, coupled with Russian jamming tactics, have reduced the effectiveness of our Voice broadcasts. Mr. Herrick believes that the new installations will bring our Voice up to the strength of Radio Moscow in a considerable area of the Iron Curtain states and will add millions of listeners to those now hearing the Voice.

FREE

MONEY MAKING
FCC
Commercial Radio Operator
LICENSE
INFORMATION

TELLS HOW—

WE GUARANTEE
TO TRAIN AND COACH YOU AT HOME IN SPARE TIME UNTIL YOU GET
YOUR FCC LICENSE
If you have had any practical experience—Amateur, Army, Navy, radio repair, or experimenting.

TELLS HOW—

OUR AMAZINGLY EFFECTIVE JOB-FINDING SERVICE HELPS CIRE STUDENTS GET BETTER JOBS. HERE ARE JUST A FEW RECENT EXAMPLES OF JOB-FINDING RESULTS:

GETS CIVIL SERVICE JOB

"Thanks to your course I obtained my 2nd phone license, and am now employed by Civil Service at Great Lakes Naval Training Station as an Equipment Specialist."
Kenneth R. Leiser, Fair Oaks, Mtd. Del., McHenry, Ill.

GETS STATE POLICE JOB

"I have obtained my 1st class ticket (thanks to your school) and since receiving same I have held good jobs at all times. I am now Chief Radio Operator with the Kentucky State Police." Edwin Healy, 264 E. 3rd St., London, Ky.

GETS BROADCAST JOB

"I wish to thank your Job-Finding Service for the help in securing for me the position of transmitter operator here at WCAE, in Pittsburgh."
Walter Koschik, 1442 Ridge Ave., N. Braddock, Pa.

GETS AIRLINES JOB

"Due to your Job-Finding Service, I have been getting many offers from all over the country, and I have taken a job with Capital Airlines in Chicago, as a Radio Mechanic."
Harry Clare, 4537 S. Drexel Blvd., Chicago, Ill.

TELLS HOW—

EMPLOYERS MAKE JOB OFFERS LIKE THESE TO OUR GRADUATES EVERY MONTH!

Letter, October 11, 1951, from Chief Engineer, Broadcast Station, North Carolina. "Need men with radiotelephone 1st class licenses, no experience necessary. Will learn more than at average station for we are equipped with Diesel Electric power, transmitting and studio equipment".

Telegram, October 2, 1951, from Chief Engineer, Broadcast Station, Wyoming, "Please send latest list available first class operators. Have November 10th opening for two combo men".

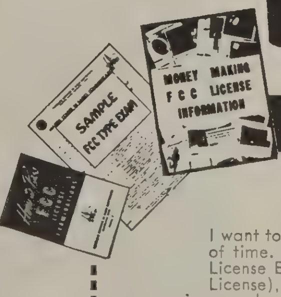
Letter, October 8, 1951, from Chief Engineer, Broadcast Station, Texas, "Please send list of latest licensed graduates".

These are just a few of the examples of the job offers that come to our office periodically. Some licensed radioman filled each of these jobs; it might have been you!

Ours is the only home study course which supplies FCC-type examinations with all lessons and final tests.

ACT NOW!

Get All 3 FREE



Your FCC ticket is Always Recognized in All Radio Fields as Proof of Your Technical Ability.

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR COACHING AT HOME IN SPARE TIME:

Name and Address	License	Lessons
Lee Worthy, 2210½ Wilshire St., Bakersfield, Cal.	2nd Phone	16
Clifford E. Vogt, Box 1016, Dania, Fla.	1st Phone	20
Francis X. Foerch, 38 Beucler Pl., Bergenfield, N. J.	1st Phone	38
S/Sgt. Ben H. Davis, 317 North Roosevelt, Lebanon, Ill.	1st Phone	28
Albert Schoell, 110 West 11th St., Escondido, Cal.	2nd Phone	23

CLEVELAND INSTITUTE OF RADIO ELECTRONICS
Desk RE-36, 4900 Euclid Bldg., Cleveland 3, Ohio

MAIL COUPON NOW

Cleveland Institute of Radio Electronics
Desk RE-36—4900 Euclid Bldg.
Cleveland 3, Ohio
(Address to Desk No. to avoid delay.)

I want to know how I can get my FCC Ticket in a minimum of time. Send me your FREE booklet, "How to Pass FCC License Examinations" (does not cover exams for Amateur License), as well as a sample FCC-type exam and the amazing new booklet," Money-Making FCC License information."

Name..

Address..

City..Zone....State..........

Paste on penny postcard or send air mail.

ROBERT H. MARRIOTT, one of radio's earliest pioneers, died October 31 at the age of 72. His radio career dated back to 1897.

Mr. Marriott was one of the moving spirits in the formation of the Institute of Radio Engineers in 1912, and is often referred to as the founder of that organization. He was a former president of the Institute, as well as of the earlier Wireless Institute. His career included work as active or consulting engineer for most of the earlier wireless concerns and the U.S. government. He was also the holder of many radio patents.

UNDERWATER AMPLIFIER, operating 1,700 feet below the ocean surface and 200 miles from land, will speed the transmission rate of the Western Union cable in which it is inserted from 500 to 1,500 letters per minute. It was exhibited recently aboard the cable ship *Lord Kelvin.* The amplifier is contained in a steel tube roughly a foot in diameter and four feet long. The interior of the cylinder is filled with oil to equalize the pressure of 700 pounds per square inch at sea bottom.

The most remarkable thing about the amplifier is that it receives its power from a supply source located 1,200 miles away. The circuit is similar to that of a d.c.-type radio (a.c.-d.c. without rectifier and filter). The required 0.3 ampere is sent along the cable, where it interferes in no way with the messages, and a dropping resistor between the positive input lead and filaments provides the plate voltage, as in a standard a.c.-d.c. or d.c. receiver. Voltage drop along the cable is fantastic, of course, and more than 2 kilowatts must be supplied at the shore station, in this case in Long Island, to furnish the 50 watts or so used by the repeater submerged off the coast of Newfoundland.

The amplifier is a push-pull resistance-capacitance coupled type. It has three stages, with four tubes in the third stage. Tubes are Western Electric long-life type, expected to give 20 years continuous service. The tubes themselves and closely associated components are placed in a depressurized, sealed cylindrical case of heavy metal inside the main cylinder, as the tubes would not stand the heavy underwater pressure. A standby amplifier forms part of the equipment.

ILLEGAL TV RELAYING by two brothers of Shadyside, Ohio, was charged by the Government in a Federal Grand Jury action.

Walter S. and Earl N. McGuire allegedly boosted signals from stations outside their area and relayed them over an antenna they set up for reception by persons who could not otherwise have received TV programs.

AN ABRUPT RECESS was given to color television, as our readers are aware, by the recent government order halting commercial color broadcasts to conserve scarce materials. Some slight dislocation was occasioned a number of sections of the industry, notably those producing color conversion kits, adapters, and to CBS-Columbia and others who were commencing to make complete color receivers.

It was first believed that the order would prevent all developmental as well as commercial operations, but further clarification indicated that the ban would not apply to experimental work.

Not least affected was this magazine. We had on hand a number of articles on color conversion and servicing, which will now be held up till color broadcasting again becomes a live issue.

—end—

Courtesy Western Union

The cable amplifier starts out on its journey for service in the silent depths.

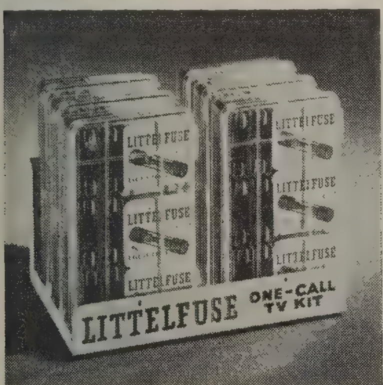
there are many chinese copies
...but ONLY VEE-D-X makes the JC
By Far The World's Most Popular Yagi
also VEE-D-X Originals
THE COLINEAR
LIGHTNING ARRESTER
OUTBOARD BOOSTER
ROCKET BOOSTER
隄防假冒
BEWARE OF CHINESE COPIES . . . INSIST ON Genuine VEE-D-X
ORIGINATORS of The World's Most Powerful Antenna Systems

Merchandising and Promotion

I.D.E.A. has designed a new yellow-and-black counter card to display its Regency TV signal booster on counters and shelves or in windows.

The Hallicrafters Co., Chicago, is offering a merit award for outstanding achievement by new novice-class radio amateurs who work all states between 12:01 a.m. September 8, 1951, and 12:00 p.m. September 7, 1952, and have obtained their regular ham licenses. The first ten novices to qualify will receive a Hallicrafters S-76 receiver and all others will receive $25 in cash.

Littelfuse, Inc., Chicago, has designed a space saving metal rack for wall or counter displays of its "One Call TV Kit". The kit is a hinged, plastic box which provides service technicians with



nine of the most needed types of TV fuses and six "Snap-On" TV fuse holders. There are 45 fuses in all, packed five each in vest pocket size metal boxes.

Javex, Garland, Texas, is distributing new counter, window, or wall sales display aids. One card displays a 300-ohm wall plate with plug and twin lead. Another card shows Javex high-voltage probes.

Acme Electric Corp., Cuba, N. Y., has prepared a special catalog illustrating its facilities for producing transformers and other components for electronic and electrical equipment. The catalog is meant primarily for contractors engaged in producing military equipment.

Radio Merchandise Sales, Inc., New York City, has reactivated its technical service forums for television distributors and their customers. The first of the series was held before the Syracuse TV Accessory House at Elmira, N. Y.

General Electric's Tube Department sales and engineering personnel is bringing the G-E tube development story to its customers with a series of tube application clinics. G-E engineers visit plants of major industrial, transmitting and receiving tube customers and conduct half-day meetings with their engineering staffs.

Helipot Corp., South Pasadena, Cal., has issued a new three-color catalog showing the facilities of its two potentiometer manufacturing plants.

Tetrad Co., Los Angeles, has released a new bulletin illustrating its copper-wire windings and the specialized electronic components in which they are used. In line with current trends, the bulletin emphasizes miniaturization.

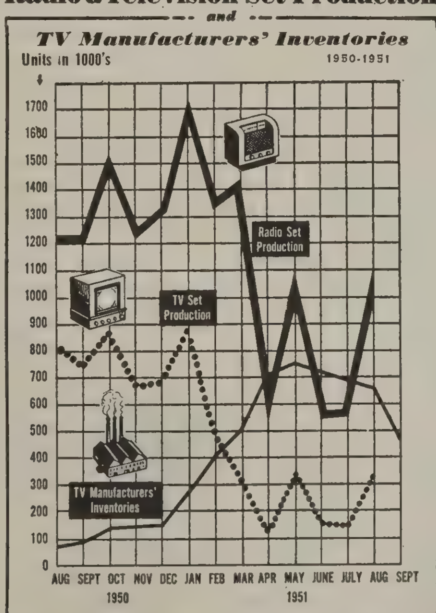
Production and Sales

NBC TV Sales Planning and Research Department announced that there were 14,003,500 television sets installed in the U.S. as of October 1. A breakdown of this figure showed that New York had 2,550,000; Los Angeles, 1,025,000; Chicago, 995,000; Philadelphia, 903,000; and Boston, 787,000. Hugh M. Beville, director of the department, announced that half of all the families in TV reception areas throughout the country already own television sets. This total represents about 31% of all U.S. homes.

The RTMA reported that 23,761,253 radio receiving tubes were sold during the month of August, an 80% increase over July sales. This brought the total for the first eight months of 1951 to 252,849,145 as compared with 227,773,373 for the same period of 1950. An analysis of the August figure showed 12,917,526 tubes were sold for new equipment, 7,230,419 for replacements and the balance for export and for government agencies.

The RTMA also reported that 210,043 TV picture tubes valued at $4,327,234 were sold to set manufacturers during the month of August. This brought the total sales for the first eight months of 1951 to 2,851,222, valued at $72,714,437. Of the tubes sold in August, 98% were 16 inches or larger in size, and 93% were rectangular in shape.

Radio & Television Set Production
— and —



New Plants and Expansions

Allen B. Du Mont Laboratories television receiver manufacturing plant in East Paterson, N. J., has been partially converted for military production. Paul Eshleman, Du Mont's production control manager during World War II,

heads the manufacturing operations in East Paterson. Mr. Eshleman personally designed and supervised the conversion of this former Wright Aeronautical plant into a television receiver manufacturing operation.

Thompson Products, Inc., Cleveland, manufacturer of aircraft and automotive parts, recently purchased the Antenna Research Laboratory, Columbus, Ohio. The company plans to manufacture a complete line of antenna products for communications, aircraft, and navigation purposes. An official of the firm stated that there were no immediate plans for home TV antenna manufacturing.

Radio Receptor Co., Inc., Brooklyn, N. Y., manufacturer of radio and electronic equipment, is increasing its plant's capacity and will manufacture germanium diodes.

General Electric has begun shipment of two-way radio equipment from its new Utica, N. Y., plant. The plant will be devoted exclusively to the production of this equipment. Production is being transferred gradually from the company's Electronics Park plant, Syracuse, N. Y.

Copperweld Steel Co., Glassport, Pa., has purchased the outstanding stock of the Flexo Wire Co., Inc., Oswego, N. Y. It will be operated as a wholly owned subsidiary of Copperweld for the production of small and fine sizes of Copperweld wires and cables for the electronics and electrical appliance industries.

The Esquire Radio Corp., Brooklyn, N. Y., was recently established for the production of clock-controlled radios. A. R. Lieberman, formerly chief engineer and general manager of Jewel Radio Corp., is president.

Thomas Mold & Die Co., Wooster, Ohio, has announced plans to expand its present production facilities to meet the growing demand for its "Sky-Hi" masts.

Crest Laboratories, Inc., Far Rockaway, N. Y., recently increased its floor space to accommodate increased production brought by additional government orders.

Phalo Plastics Corp., Worcester, Mass., has renovated its testing laboratories and added new equipment.

Business Briefs

. . . **Thomas Electronics Inc.,** Passaic, N. J., has begun production of small vacuum tubes for original equipment and replacement. The company previously limited its production to TV picture tubes.

. . . **The RTMA** Board of Directors approved membership applications of the following companies, bringing its membership to 329: L. H. Frost & Co., Grand Rapids, Mich.; Hardwick, Hindle, Inc., Newark, N. J.; Hughes Aircraft Co., Culver City, Cal. and Jeffers Electronics, Inc., DuBois, Pa.

. . . **RCA Victor Division** announces plans to enter the home air-conditioning field in January, 1952, when it will place its first unit on the market.

. . . **Tung-Sol Lamp Works Inc.** has changed its corporate name to Tung-Sol Electric Inc., to give a more accurate description of its activities and products.

. . . **General Electric's** Tube Department, Schenectady, N. Y., has announced an advanced course in television service, including set conversion. Radio and TV service technicians may sign up for the course through their distributors.

. . . **The 1952 Electronic Parts Show's** corporation manager, Kenneth C. Prince, announces that contract forms and brochures have been mailed to member exhibitors. The show, which will be held in the Hotel Stevens in Chicago on May 19 through 22, will be the only industry-wide national parts show to be held in 1952.

. . . **The NPA** has issued an order, M-85, granting priority assistance to FCC-licensed amateur radio stations and stations used by the Civil Air Patrol in obtaining supplies for maintenance and repair for existing stations and for building new stations.

. . . **Sarkes Tarzian, Inc.,** Bloomington, Ind., held a symposium on u.h.f. at Bridgeport, Conn., at which it demonstrated its new v.h.f. tuner, TT16. This tuner features 12-channel v.h.f. performance plus a u.h.f. position in which the tuner is changed to an amplifier for u.h.f. i.f. systems. It is available for receivers with either 21- or 41-mc i.f.'s.

. . . **RCA Service Co.,** Camden, N. J., announces that 25 field engineers and technicians have completed the second postgraduate training course in theater television installation and service techniques.

. . . **Kaye-Halbert Corp.,** Los Angeles, has formed a new national service company for providing better service to its distributors and dealers.

. . . **The Eidophor-CBS** large-screen theater color television, shown earlier this year in Switzerland, will be demonstrated in the U. S. before the end of the year by the 20th Century-Fox Film Corp.

. . . **The Radio and Electronics Society of India** will hold an International Exhibition in Bombay from **February** 9 to 29, 1952. The exhibition will afford manufacturers and distributors all over the world a chance to study the needs of Indian and Asian electronic buyers.

. . . **Sightmaster Corp.,** New Rochelle, N. Y., was issued two new patents involving the processing of glass for TV picture tubes to permit a true transmission of all colors evenly.

. . . **The Electrovox Co., Inc.,** East Orange, N. J., announces that replacement data on its "Walco" needles have been made available through the Howard Sams Photofact folders.

. . . L. S. Thees, General Sales Manager of the **RCA** Tube Department urged the industry's radio battery dealers to capitalize on the popularity of portable radios with aggressive merchandising and promotion. He said portables now account for about 20% of all radio sales.

—end—

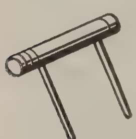
Know "WHY" Ceramic Capacitors...

Here are the facts about Ceramic Capacitors — why they are the most permanent capacitors . . . why they do a better job . . . give a better performance . . .

Up until a few years ago, capacitor design was based on one idea — "the bigger the better." Paper and mica, etc., were cheap, readily available materials, and their use was the only known art for making commercial capacitors (or "condensers" as they used to be called).

Now don't misunderstand us . . . those old condensers were really OK as far as they went. *But today there's something more to talk about* . . . CERAMIC CAPACITORS.

Actually, the idea of ceramic capacitors isn't new. They've been used as electronic components for more than 20 years. We call them new because it's only in the last few years that service-engineers have paid any attention to them . . . and because some of these modern ceramic capacitors really are new . . . with *new* higher voltages, *new* and better physical characteristics. So if ceramic capacitors were overlooked by service-engineers during the last few years . . . we feel it's because you didn't know about just how *good* they really are—or because what you needed wasn't available.

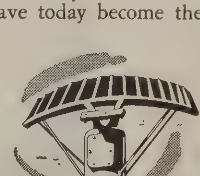


Let's take a look at modern ceramic capacitors and the story behind them. It was in the early 1900's when German scientists discovered the dielectric properties of ceramic materials. In the U.S.A., we had an abundant supply of mica and other materials, so U.S. research men never bothered with ceramics. Then came World War I, and ceramics became mighty important in European radio manufacture. Ceramics were a long way from perfected but they did the job . . . and continual improvement made them increasingly important in the electronic field. Meanwhile, at Centralab, we had started to investigate these new materials. It was soon found that U.S.A. had a bigger source of raw ceramic materials and that our stocks were of vastly superior physical and electrical characteristics.

Then one of our foreign representatives supplied us with a complete set of foreign-made ceramic components. Result — Centralab developed a ceramic research program. The program was big and thorough . . . and it's still going on.

In a few years, Centralab put on the market its first ceramic capacitors. With World War II, came tremendous developments in electronics. Radio, radar and other electronic equipment demanded the finest in component parts . . . and ceramic capacitors came into their own. *In fact, independent research has shown that during World War II, in some classes of military equipment, there was not a single known instance of a failure of a ceramic capacitor!*

Thus, through the lessons learned over a period of 20 years of intensive research — Centralab Ceramic Capacitors have today become the best capacitor buy for safe guaranteed servicing. For when you use CRL ceramic capacitors, you're using the benefits of hundreds of thousands of man-hours of research—experiments with over 20,000 different ceramic compounds!



That's why any ceramic isn't the best ceramic for the job. Each of those 20,000 ceramic mixes had definite physical and electrical characteristics . . . and when we say that Centralab today uses only 250 of those 20,000 tested compounds, you can be sure that those discarded did not perform to the exacting requirements of sensitive electronic circuits.

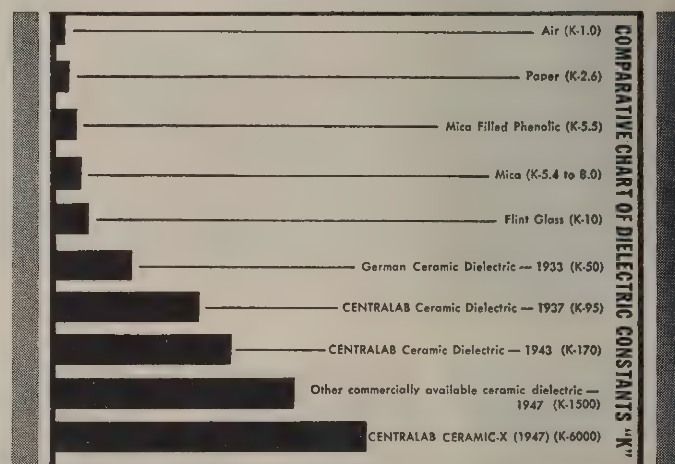
Yes, and if you compare the old-style paper and mica capacitors with modern ceramic capacitors . . . point for point, based on your own technical experience, you'll see why ceramics are vastly better . . . the safe, dependable way to assure a good service job.

For example, every serviceman is aware of the moisture absorbing quality of paper condensers . . . and how moisture can seep in along the leads on mica units. Compare these old designs with modern ceramic tubular and disc types . . . Centralab's Ceramic-X capacitor bodies are nonhygroscopic . . . moisture absorption being only .007% or less! That fact alone means Centralab Capacitors give you and your service customer the ultimate in reliability—even under severe tropically humid conditions.

Old-timers in the service field . . . yes, and young ones, too, will recall the bulky size . . . the difficulty of handling old-fashioned large size capacitors . . . when size seemed to be an important factor in design. Now, look at modern ceramic capacitors. They're less than 1/7 the size . . . you can fit them anywhere!

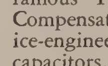
When you look at this chart of the development of capacitors using various materials . . . the tremendous improvement of the dielectric constant "K" with the entry of ceramics into the field is dramatically evident.

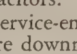
One of the most serious problems with old-time capacitors was that they broke down under high temperatures. Here again, ceramics have more than proven their superiority. 85° C. will not harm the modern ceramic capacitor. In fact, the ceramic body itself can easily withstand any temperature encountered in electrical apparatus. High capacity is



well maintained under wide temperature variation. What's more, the copper-silver electrodes are electro-bonded to the ceramic with a tensile strength of 30,000 lbs. per square inch — thus preventing any possible change of the relative position of the electrodes.

A typical example of the high degree of perfection and performance offered by ceramic capacitors is contained in CRL Hi-Vo-Kaps. These units are rated at 10 — 20 and 30 KV and are intended exclusively for TV. You'll find that practically the entire TV industry has standardized on these CRL units as original equipment for this most exacting application.





When it comes to low power factors—check ceramics against all others. With ceramics, initially it's .1% to .6%. After 100 hours at 95% humidity, it's .5% to 3% and they'll return to normal! That's ceramic high efficiency! If it's accuracy you want, ceramic capacitors can give you unusually close tolerances in wide range of values.

In r.f. circuits, where drift is critical, one of the likely causes is temperature change. Stabilization can be effected by capacitors which compensate for temperature variations. Centralab pioneered ceramic capacitors for this purpose. This important research resulted in Centralab's famous TC-Hi-Kaps Zero Temperature and Negative Temperature Compensating units. These are a Centralab exclusive "First". For service-engineers they are the industry's last word in accurate stabilizing capacitors.

Service-engineers today are called upon for more exacting work — more downright customer satisfaction. Every job that comes into your shop is a challenge to your reputation. Regardless of the care in workmanship, no service job is better than the components you put into it. To stay in business tomorrow — you can't take chances today.

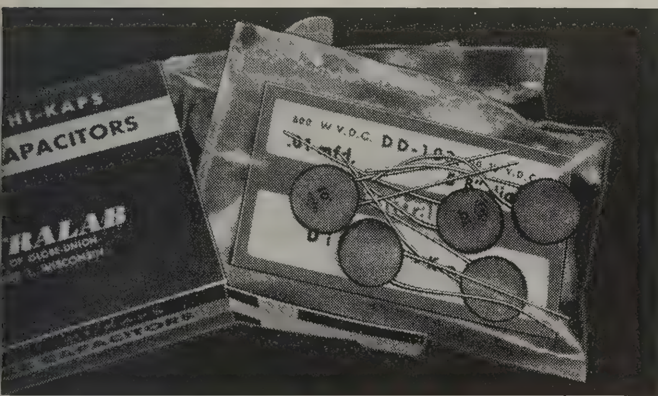
Field research shows that smart service-engineers everywhere *are replacing all old-fashioned or dangerously old capacitors with ceramic capacitors,* within the capacity ranges available. Particularly if there is any indication of possible failure within a reasonably short period. For by-pass and coupling applications . . . they're using Centralab BC Hi-Kaps. For tuning applications, they're using temperature compensating TC Hi-Kaps. It's their own assurance of a good job well done . . . and their customer's insurance of complete satisfaction. What's more, to the serviceman and customer alike . . . *there's little or no premium in price.*

* * *

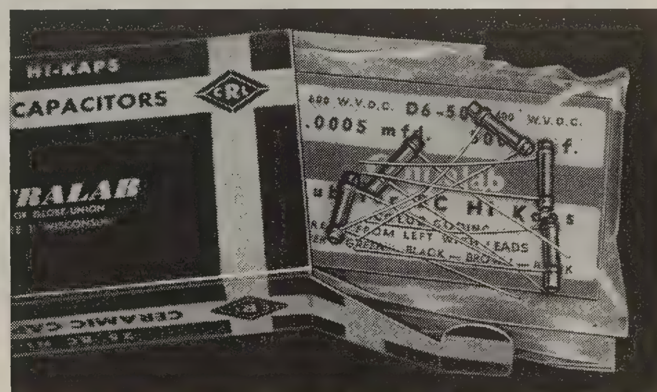
You'll find Centralab ceramic capacitors are available in a wide variety of capacities from any recognized better radio parts distributor. Ask him. And remember, Centralab is the pioneer in the field of electronic ceramics. That fact alone is your best assurance of engineering know-how, production know-how, and performance know-how that permits no compromise with quality.

and you'll Buy Ceramic Capacitors

Choose the exact capacitors you need from the world's widest line of ceramic capacitors — for jobs that demand the best in guaranteed TV-AM-FM servicing . . .



CERAMIC DISC HI-KAP CAPACITORS — provide very high capacity in extremely small size, with minimum thickness. For by-pass, coupling and general applications. Superior power factor and low inductance.



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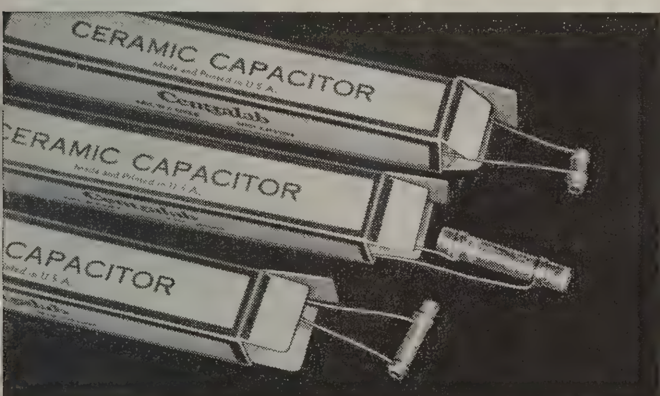
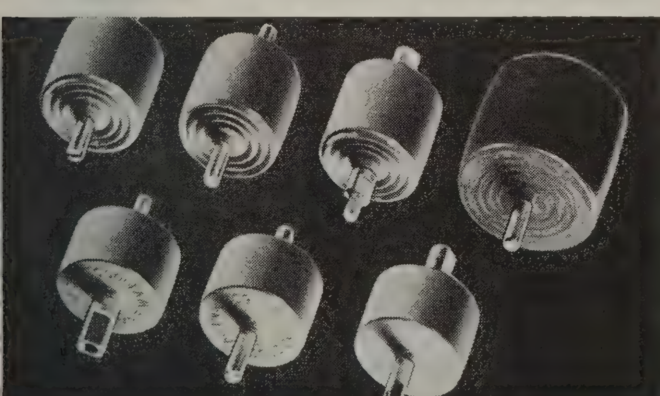
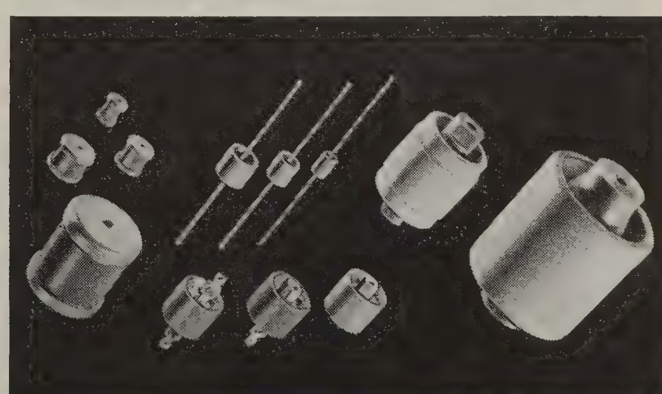


TC TEMPERATURE COMPENSATING CERAMIC CAPACITORS — stable units that do not change in capacity under wide temperature variations—or may be selected to correct for frequency drift in resonant circuits caused by temperature changes. Also superior replacement for close tolerance micas.

CAPACITOR KITS — several are available. Illustrated is assortment of 200 units of most generally used values, supplied in a four-drawer metal cabinet. Often assures required values will be on hand when needed in labs or for service. No charge for cabinet.



TELEVISION HIGH VOLTAGE CAPACITORS — the accepted standard for the TV industry. Used for filter and by-pass in TV high voltage power supply and pulse filter for cathode ray tubes. Ask for Centralab Hi-Vo-kaps.



TRANSMITTING AND HIGH ACCURACY CERAMIC CAPACITORS — for applications involving rigid frequency control. Used for holding oscillator frequencies to close limits. Excellent as secondary Standards.

Yes, for the safest, quickest guaranteed servicing . . . standardize on Centralab Ceramic capacitors. You'll have the world's widest line to select from — as made by Centralab, *America's pioneer builder of ceramic capacitors.* You can get complete information on all the capacitors described here — plus other valuable service information from Centralab's Catalog 27 . . . available at your distributor's.

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Is The Vacuum Tube DOOMED?

. . . The Vacuum Tube's Competitor Is Rising Fast . . .

By HUGO GERNSBACK

ONE of the foremost, if not the greatest, invention of recent times was Dr. Lee de Forest's three-element vacuum tube. It would be difficult to cite a single other invention that has benefited man in so many different ways as has the vacuum tube, which gave birth to a new giant—radio-electronics.

Since the first vacuum tubes appeared on the market, not long after the turn of the century, many billions of such tubes have been manufactured all over the world. This tempo has been accelerated from year to year, is still increasing, and will probably continue to increase during the present decade. The world annual output of vacuum tubes is colossal, reaching about half a billion. They are made in all sizes, from the miniscule types, smaller than a pea, to huge transmitting types weighing hundreds of pounds each. Vacuum tubes have been well standardized during the past two decades and their life is usually quite long. Thus many radio receiving sets with their original tubes, from the early twenties—when broadcasting started—are still in use. Some of these ancient tubes have an astonishingly long life and if not used continuously still perform well.

One would think that such a fragile instrument as a vacuum tube would have a very short life, but such is not the case. The average tube giving normal service lasts long, if not electronically worn out by a current overload.

Nevertheless, the vacuum tube has serious shortcomings, the foremost of these being:

(1) Bulkiness. (2) Electric current drain. (3) Vulnerability to severe shock.

There are also many other disadvantages of a technical nature, which we need not go into here. Before the vacuum tube came into active use there was a fascinating device which was widely used in wireless communication—the crystal detector. It was also a rectifier which needed no current of any type, neither A nor B—it supplied its own current from the rectified radio waves. It operated efficiently, was light in weight, and was practically everlasting.

It had, however, several inherent disadvantages. It was easily put out of commission, even by slight shocks or jars; it was insensitive, and it could not be used as an amplifier, and it did not oscillate, as did the vacuum tube.

Later, in 1924, a Russian experimenter, O. V. Lossev, invented an oscillating crystal which actually worked. This achievement was first reported in the American press in one of the writer's former magazines in September, 1924. This oscillating crystal, however, did not come into general use because it was highly temperamental. It was difficult to adjust and keep going. The "bugs" were never ironed out.

It was not until the end of World War II that the scientists, J. Barden and W. H. Brattain, of the Bell Telephone Laboratories, after years of painstaking work, developed a perfect crystal which in all practical respects duplicates the vacuum tube. This is the *transistor*. The modern transistor has three terminals, just as the original vacuum tube, but as it does not require a filament current, it becomes much more flexible, is very much lighter, and, as now manufactured, is impervious to the most violent shocks. As there is nothing to wear out, it should last practically forever. The transistor, which is smaller than a pea, is also an amplifier. But when connected in cascade with transformers for power purposes, electric current must be used to energize it.

The new transistors, for certain purposes, are ideal, particularly where weight and space are at a premium, such as in airplanes, many important war devices, etc. When the transistor is used with printed or appliquéd wiring, weight and space are still further reduced. Certain radio components, such as variable resistors, switches, relays, etc., have recently been miniaturized to such an extent that the size and weight of these devices have been reduced astonishingly. The only component which has not been greatly miniaturized is the transformer, although advances have been made.

Using the new molecular loudspeaker reported in the last issue of RADIO-ELECTRONICS, it would seem possible that during the next few years an excellent superheterodyne radio receiver, no larger than a wrist watch, could be designed.

Will the transistor make the vacuum tube obsolete in the near future? This is much to be doubted. The vacuum tube will always have certain advantages over the transistor. It must also not be forgotten that for many years to come people will still use their present radios and television sets. Vacuum tubes therefore will still have to be manufactured by the billions to take care of replacements. This is true not only of home devices but for industrial, maritime, commercial, and military devices.

What keeps the transistor from displacing the vacuum tube in the immediate future? This is mainly an economic question, because the cost of the transistor today is much greater than that of the vacuum tube. At the time we go to press, the price of the transistor is $18.00. Also the transistor so far does not operate on all frequencies. Mass production has not yet been evolved. There are still many manufacturing "bugs" to be straightened out. This may take some years.

What also, in the writer's opinion, will hold back the transitor is its present name. The public never has taken kindly to it and probably never will. The word "crystal," from the Greek "Krystallos" is the basis for a popular name. I would seriously suggest that, particularly for public consumption, a new name should be adopted. I advance the term "crystron" (crys=crystal; 'tron=electron). This is what the device is—an electronically operating crystal. The adoption of this designating name *now* will do away with a great deal of confusion in the future.

Radio-Electronics wishes its readers a Happy Christmas and prosperous New Year

Courtesy Underwood and Underwood

Important Factors in HIGH-QUALITY AUDIO

By WALLACE WANER

THE high-fidelity fan is always seeking a new and better circuit from which to build that "perfect" amplifier. His choice of a good schematic usually can be taken for granted, but there is little assurance that the finished product will come up to his high expectations. Too often a number of factors not indicated on the wiring diagram are overlooked. They may be just the factors that make the difference between complete satisfaction or keen disappointment with the finished product.

These factors apply with equal importance to any type of audio amplifier. For this reason no specific circuit is analyzed in this article. By modifying existing amplifiers, or by incorporating these essentials in proposed construction, it will be easier to achieve the type of true high fidelity which gives the listener a sense of "presence" and of on-the-scene realism.

The output transformer

Perhaps the most misused component in an audio amplifier is the output transformer. This unit definitely should be on the husky side. Instead, it is often too skimpy for the output of the amplifier. The result is that the core saturates with only a few watts of audio power. Besides the distortion usually introduced by the small transformer, the undersize core and inadequate copper content of the windings not only limits power output but gives unequal amplification over the desired frequency range.

A good example of the variation in output transformers is shown in the photograph. The smaller transformers are each rated at 20 watts. Each saturates and has a high distortion factor long before this power is reached. Actually, such a 20-watt rating is more indicative of how much these transformers can handle before burning out rather than how much *audio power* they will deliver with high fidelity. By comparison, the high-quality transformer at the left is rated at 15 watts of audio power, yet is larger than the two which are rated at 20 watts! Obviously, ratings do not always tell us the whole story about an output transformer.

Many new audio enthusiasts have found, to their surprise, that a good-quality audio-output transformer with a rating of 10 or 15 watts is as big as a power transformer.

Advantages of large size

The need of a big output transformer can be understood more easily when we consider what the audio amplifier wants from it. Suppose two 6L6 tubes are used in push-pull class A1, which will furnish approximately 18 watts of audio power with only 2% total harmonic distortion. Each half of the primary winding will have over 50 milliamperes of current flowing through it, besides the audio-signal current variations.

Using a power-supply voltage of about 250 volts for the 6L6 tubes, the a.c. audio signal will swing up to 400 volts peak value with full grid input. Plate current will run over 70 ma per tube. With such current and voltage values you can get best results and proper performance at high output levels only with large diameter wire and plenty of core. The larger core increases permeability, which in turn increases the inductance of the windings. This means that the number of turns can be reduced by the manufacturer in both primary and secondary windings and still hold the inductance to the desired value.

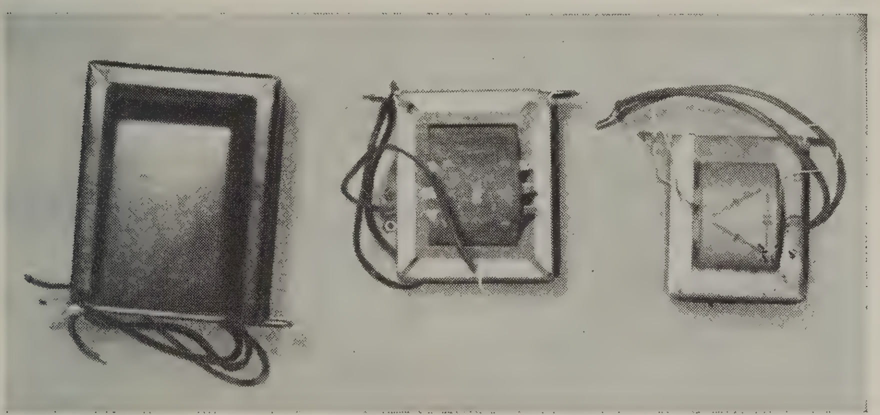
The immediate benefit of fewer turns is a reduction of distributed capacitance

between the windings. Less capacitance means less shunting effect on the higher audio frequencies. The reduced number of turns also decreases the resistive component of the windings and thus cuts down on audio power dissipation in the transformer.

The temptation to buy the cheapest output transformer (or to use that odd one lying around) must be shunned if high fidelity with reasonable power output is the goal. The extra cost of the bigger job pays off in improved performance.

Impedance matching

The load resistance for the output tubes and the voice coil must be properly matched. Neglect here can undo the benefits of the larger size transformer. Unless the impedance match is correct, maximum power output cannot be obtained from the audio amplifier power output tube. If too low an impedance is reflected to the tube, quality may drop, too.


A good 15-watt and two so-called 20-watt output transformers compared for size.

The necessary *turns ratio* between the primary and secondary can be calculated by the simple formula:

$$\text{Turns ratio:} \quad \sqrt{\frac{\text{Primary Z}}{\text{Voice coil Z}}}$$

The primary impedance actually refers to the preferred load resistance. This information can be found in the tube manual. If, for instance, the load resistance is 2,500 ohms (typical for a triode 6A3) and the voice-coil impedance is 5 ohms, we get the following:

$$\sqrt{\frac{2500}{5}} = \sqrt{500} = 22.5 \text{ (approx.)}$$

This would mean that a satisfactory transformer would have 22.5 times as many turns on the primary as on the secondary.

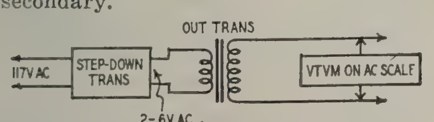


Fig. 1—Setup for finding turns ratio.

The turns ratio of a transformer can be found by measuring its voltage step-up ratio, which is the same as the turns ratio. Fig. 1 is a typical setup. Apply a small known voltage to the primary and measure the stepped-up voltage across the secondary. Dividing the secondary voltage by the a.c. voltage applied to the primary gives the turns ratio. As an example, if 2 volts is applied to the voice-coil winding of an output transformer and 60 volts is read across the plate winding, the turns ratio would be 30 to 1. (It is preferable to use a small value of a.c. voltage on the voice-coil winding to prevent overheating.)

The loudspeaker

A common fallacy is that the larger the cone the better the speaker. This is far from true. Loudspeaker efficiency and power-handling capabilities depend on several factors other than mere cone size.

Regardless of make or price, the amount of undistorted power the loudspeaker is capable of delivering depends on the smallness of the gap between the pole pieces surrounding the voice coil and the strength of the magnetic field in that gap.

The frequency response may depend on cone construction, suspension, and other contributions of careful design, but the amount of power the speaker can handle without distortion depends in a large measure on the size of the magnetic alnico slug in the PM types or the magnetic field built up by the dynamic types. A small magnet slug or an undersize field coil will limit the amount of power the speaker can handle, and severe distortion will result above a few watts. Thus, a 16-inch speaker which has the same size slug as an 8-inch cannot be expected to give much better performance than the smaller one.

Understand, of course, that the larger speaker with a proportionally larger magnetic field will outperform the smaller. Too often, however, the larger speaker is used merely because of its size, and if it has an inadequate magnetic field it will be unable to deliver the required or expected audio power. This alone would not be too serious except for the fact that the large cone with the small magnet is more prone to produce such undesirable effects as cone resonance and hangover.

Hangover reduction

Hangover—in audio discussions—refers to the blending of one tone with the next—an effect similar to holding down the sustaining pedal of a piano. Musical notes which are supposed to be sharply separated in staccato fashion, blend and slur together.

The amount of hangover depends very much on the design and quality of the output section of the amplifier. Sometimes it is so slight that it is hardly noticeable, and not until it has been entirely eliminated can one appreciate the decided improvement in musical crispness and definition.

Hangover is caused by improper damping of the output circuit. It may be due to power tubes with high plate resistance (pentodes and beam tubes) or to a cone which moves too freely. When the speaker cone is pulsed by an audio field in the voice coil it moves sharply forward and back. When the musical note ends and there is a sudden absence of signal in the voice coil, the speaker cone should stop as suddenly. The laws of physics and inertia remind us, however, that the cone will not come to sudden rest, but will continue its motion for a little while—depending on its stiffness and mass. This extra movement shifts the voice coil back and forth in a magnetic field and a.c. voltage is, of course, induced in the voice coil.

This unwanted voltage reappears in the speaker and adds a trailing tone to the one just reproduced, thus destroying any possibility of sharp reproduction. Hangover can be reduced by a stiff-cone speaker and a high concentration of magnetic energy around the voice coil, for both have a damping effect. The high plate resistance of pentode tubes can be reduced by negative feedback (also called inverse feedback) as shown in Fig. 2. R can be a 500,000-ohm variable which can be replaced by a fixed resistor once the correct value has been established. C should be

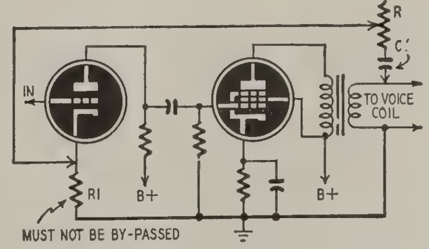


Fig. 2—This simple feedback circuit reduces the effects of a number of faults.

.05 μf or larger; it serves to prevent shorting any d.c. developed across R1. If the amplifier oscillates, reverse the tap and ground connections at the output transformer secondary, or reverse primary leads.

This type of inverse feedback can be used over several stages and will help reduce distortion and tube noises. It is particularly useful with pentode output tubes. When triode output tubes are used, their low plate impedance makes damping to reduce cone resonance and hangover effects unnecessary. Most

triode power amplifiers have very low plate resistance, so a free-moving cone speaker can be used to secure better low-frequency response from the speaker.

Output equalization

One serious disadvantage of an output transformer is that the inductive reactance of the primary varies to a considerable extent with frequency, as indicated by the inductive reactance formula:

$X_L = 6.28$ frequency inductance ($2\pi fL$).

As can be seen, with a constant inductance, each change of frequency will produce a corresponding change in the ohmic value of the reactance. This means that high tones find a higher reactance and get more amplification than the low tones which produce a much lower reactance. An equalizing circuit as shown in Fig. 3 will help compensate for this undesirable effect, for

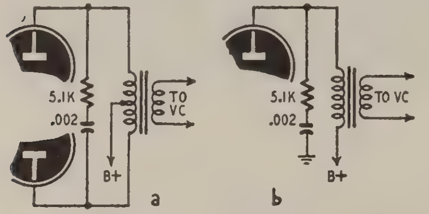


Fig. 3—The equalization circuit, for push-pull and single-ended amplifiers.

the impedance across the circuit formed by the resistor and capacitor will act in fashion opposite to the coil reactance. Find the exact values of capacitance by experiment. This type of compensation is seldom needed with triode output tubes, due to their lower output impedance as compared with that of the output transformer primary.

The sound source

Radio tuners, microphones, and phonograph pickups often introduce considerable distortion in the upper frequency ranges. The response characteristics of recordings by the various phonograph record companies also vary to a considerable extent. For these reasons reproduction can be improved by using some sort of tone control. Not the usual bypass type of tone control, however. An actual R-C low-pass filter network as shown in Fig. 4 is a much more satisfactory method of equalization and high-frequency noise attenuation.

The one at *a* is variable and can be adjusted so that attenuation begins at the upper ranges of the phono pickup or radio tuner. The nonvariable type shown at *b* can be used after experimenting with C1 and C2 values for proper reduction of noise and distortion. These could range from .002 to .005 μf. The larger values attenuate most. Once the proper values have been established, the filter network can be inserted in the grid input circuit of an amplifier stage as shown. The coupling capacitor value and the grid leak are left undisturbed.

The values of R1 and R2 should be approximately 47,000 to 56,000 ohms. In Fig. 4-a, a knob can be brought out on the front panel for manual control.

High-frequency audio losses

The foregoing does not imply that a wide-frequency-response amplifier is not desirable, for it is. With a high-quality pickup extending to well above 15,000 cycles with little noise, the high tones should not be diminished.

The same holds true for an FM tuner where audio ranges to 15,000 will be received. In such instances a flat-response amplifier to 15 or 20 kc is highly desirable to reproduce the overtones so essential to definition and presence.

One oversight which often has a serious effect on the frequency range of a good amplifier is the use of too long shielded leads from the phono pickup to the input of the amplifier. It is, of course, necessary to use shielded cable from the sound source to the amplifier input, because the high gain of the first stage will pick up hum or introduce squeals and whistles. The input cable, however, must be kept as short as possible, for the capacitance losses between inner conductor and outer shield are high for just a few feet of length. Even if we have an amplifier with a response flat to 15,000 cycles, we can easily spoil this range by using an excessively long shielded cable between the sound source and the grid of the input tube. Every foot or so that is eliminated makes a pronounced difference in high-frequency output.

On new construction it is advisable to guard against running signal-carrying wires too close to chassis. If grid and plate leads, or load resistors, are positioned too close to chassis or circuit wiring, capacitance will again hamper high-frequency reproduction.

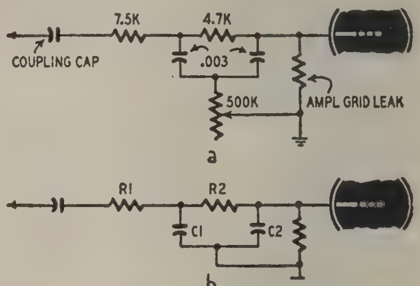


Fig. 4—The filter type tone control.

All the foregoing will become meaningless if you try to get too much out of your amplifier. You must have a well-designed circuit, capable of handling the amount of audio power you desire without distortion. Pushing an amplifier beyond what it can handle will undo the best design and workmanship.

—end—

Shut-In's Ear Extender

An invalid or shut-in who is confined to one room soon tires of the sameness of radio programs and phonograph recordings, and longs for the sounds he heard before being confined. His hearing range can be greatly increased and life can be made less boring if a few small PM speakers and a high-gain audio amplifier are available.

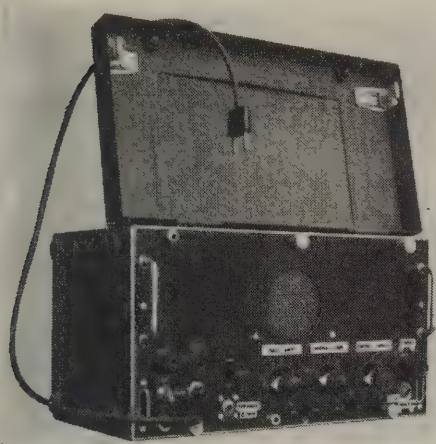
The speakers are used as microphones and are placed near the source of the sounds he wants to hear. Much of the normal family life can be brought to him through microphones placed in the kitchen, living room, near the family dining table, or on the front porch. Outdoor sounds such as bird songs, children at play, and the arrival of the newsboy with the evening paper can be picked up by microphones that are placed in nearby trees or under the eaves of the house.

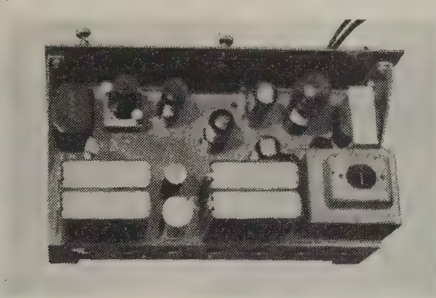
A telephone pickup should not be overlooked. You can make one by mounting a Ford spark coil—which can still be bought at Sears or Montgomery Ward, or at many auto supply houses—under the phone with its secondary connected to the amplifier input through shielded cable.

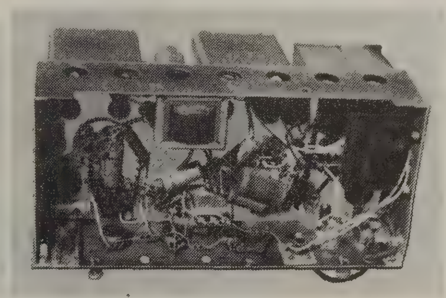
There are a number of ways in which you can rig up a suitable amplifier. A preamplifier can be rigged up to feed the microphones into the audio circuit of the radio set or you can use a small 3-tube phono amplifier with an extra 12SQ7 or similar tube added to supply the gain required. A single-pole multi-position rotary switch can be used to connect one microphone (speaker) at a time to the input of the amplifier. A more elaborate system can be worked out by using separate input circuits with gain controls for each. In this way, the listener can pick up a variety of sounds and blend them in their normal proportions.

Outdoor speakers should be mounted in metal cans—1-pound coffee cans are O.K.—with a number of small holes punched in front of the speaker. The assembly should be weathertight at the top and tilted so water cannot run or be blown into the speaker cone. Speakers mounted in trees can be concealed in a weatherproof case which can be constructed to look like a rustic bird house.

A slightly better system can be built with crystal microphones instead of the small PM speakers. The results will not in most cases pay for the extra cost of the better microphone equipment, however, though if it is available it will add somewhat, especially to the quality of the transmissions. —*E. E. Youngkin*







Left—Mr. Zoucas' amplifier viewed from the front. Hinged lid covers the panel. Center—Chassis view. Note that oil-filled capacitors were used in the original version. Right—The underchassis wiring. The output transformer is at the right.

Three-Channel Amplifier

By J. ZOUCAS

A FLEXIBLE tone-control system is an important part of any phonograph amplifier. Most high-quality amplifiers use more or less complex networks of L, C and R. They usually also require one or more supplementary tubes to compensate for the loss of gain in the compensating network.

I decided that it was simpler to split the input stage into three independently controlled channels. Two cover only a part of the audio frequency spectrum (bass and treble). The third channel covers the whole spectrum.

There are six separate tone controls. (The photos show only two, P4 and P6. The other four, S1, S2, P2, and P3, were added after the photos were taken.)

As the amplifier was designed for my living room, 8 watts was judged sufficient output. A pair of 6V6's in class AB1 deliver this at the plate voltage chosen. To lower the output impedance, negative feedback is used from the voice-coil winding of the output transformer over three stages to the 6J5 cathode circuit.

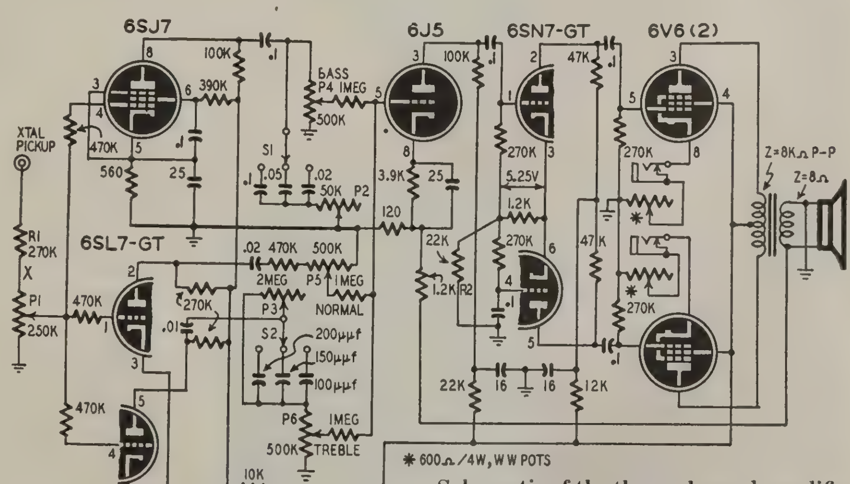
The input of the amplifier is designed for a crystal pickup. R1 is selected to limit signal voltage at point X to 0.5 volt on peaks. From here the signal goes through the volume control P1 and then divides into three parts, going to a 6SJ7 and each half of a 6SL7. The output of the 6SJ7 has a low-pass filter in its plate circuit. The crossover frequency of this filter can be adjusted by S1. The amount of bass boost is regulated by P2. The over-all gain of the bass boosting channel is controlled by the potentiometer P4 in the grid circuit of the 6J5.

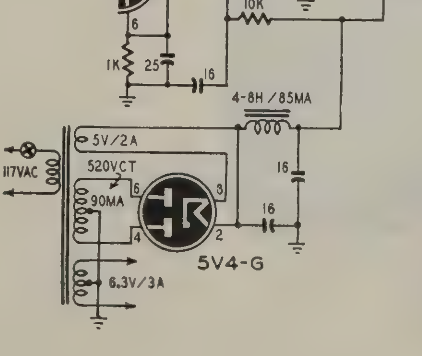
One half of the 6SL7 functions as the uncompensated stage which amplifies all frequencies. P5 controls the gain of this channel.

The other half of the 6SL7 is used as the treble channel. This channel has a variable high-pass filter in its plate circuit. S2 selects the frequency at which the channel's response begins to fall. Potentiometer P3 regulates the amount of fall. The over-all gain of the treble channel is controlled by potentiometer P6.

The output of the three separate channels is combined at the grid of the 6J5 amplifier. The 6SN7 which follows the 6J5 functions as the phase inverter using a cathode-coupled circuit. In this circuit, only one of the triode grids is driven. The other triode's grid is at ground potential as far as a.c. is concerned. The signal is fed through the cathode which is connected to the cathode of the first half of the 6SN7. Since both cathodes are well above ground, they vary at an audio rate when a signal is fed to the first triode grid. Because of the grounded grid, the second triode's plate has the same phase as the cathode, and differs by 180° from the plate of the first triode.

The 6V6 push-pull output stage is connected in conventional fashion. However, each tube has a separate cathode bias resistor (a 600 ohm, 4-watt potentiometer). A closed-circuit jack in each cathode permits metering cathode current of each 6V6. Adjust the bias to give a cathode current of 35 ma for each tube.





Schematic of the three-channel amplifier.

To get the maximum quality from this amplifier, it is of course necessary to use a high-grade output transformer. The capacitors and resistors on each side of the inverter and push-pull circuits should be accurately matched for best results. Grounds must be grouped by stages, and all groups connected to the chassis at one point. The filament winding on the power transformer was center-tapped and all filament leads were shielded.

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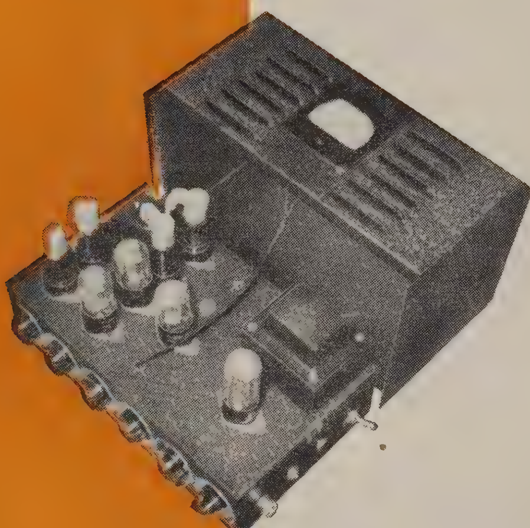

Portable MIXING PRE-AMP

High-impedance pre-amp. designed to work with tape recorders, but applicable, with slight modifications, to a wide variety of uses.

By CHARLES L. HANSEN

RECORDING companies and users of tape and wire recorders have a need for a microphone preamplifier if the recorder is to be used to its maximum capabilities. Our small recording company discovered this when we purchased two Brush portable tape recorders. Commercially available mixing preamplifiers are all excellent; however very few of the portable units are priced less than $400. Four hundred dollars will buy a lot of equipment, and expensive commercial preamplifiers are financially out of reach of our small recording company. The total cost of this home-constructed unit is approximately $60, including all parts, plus about 10 hours of labor, a worthwhile saving.

This preamplifier is designed to permit four high-impedance inputs and one high-impedance output. It is used in the studio for studio recording and is portable enough to be used for on-location recording. Dubbing from records is accomplished by use of a pickup equalizer and losser pad ahead of one or more of the inputs. More than enough gain is available when using dynamic and ribbon mikes on long cable

runs with low-impedance settings on mikes. Necessary level indicator and monitoring facilities are included and add little to the cost. In the interest of economy and good performance high-level mixing is used and there is no cross-talk between channels.

The unit has been in constant use for six months and has not developed a single case of trouble. It has been able to fill any recording requirement and has definitely proved its worth over and over again. Our latest job was recording an hour-long program of a school choral group and miscellaneous piano duets and solos. Two pianos were used and each required a mike, as they were at different stage locations. The other two mikes were used to cover the choral group.

Our job called originally for one set of records covering all selections of the group for the school record library. But after the records were heard by the group we had orders to make 79 additional 10- and 12-inch records.

Construction

Common judgment is used in parts layout and placement. The power supply is located on one end away from the low-level equipment on the other end of the chassis. The mixing tubes are next to the high-gain input tubes. All filament wires are run in shielded cable and the center tap of the filament winding is grounded. It is important to use double shielding in the grid leads of the input 6J7 tubes, and the grid resistor is contained in the shielded grid lead and located above chassis. The back covers of all potentiometers are strapped together and are then grounded to the main bus.

Filter chokes are unnecessary; there is no trace of hum in the unit. 6J7's were used in the input because the grid lead is not subject to a.c. which would have been the case if a 6SJ7 were used. Previous experience had taught us to avoid most tubes which have the grid connection on the bottom of the socket when used in low-level, high-gain circuits. We also had in mind substituting 1620's for the 6J7's if there was any heater-to-cathode hum. Note the wiring order of tube filaments. This may mean the difference between a preamplifier with hum or without hum. Shielding of the coupling capacitors between the preamp and the mixer was unnecessary. We did attempt to use two low-impedance input transformers, of the plug-in type, contained within the unit. The hum pickup was intolerable even though the transformers were the best type obtainable. Cable transformers are used, as they are less expensive than the better well-shielded mike transformers. The unit is less subject to hum pickup if the mike transformers are located a few feet away from the a.c. power transformer field. It is more versatile if all inputs are high-impedance.

The monitoring circuit makes use of one half of a 6SN7-GT. Enough gain is available for loud headphone volume for monitoring near a pickup source to override the direct sound. The original design called for switching the monitoring amplifier to various channels for sampling purposes. A single monitoring connection is used and is sufficient. The VU meter makes use of the other half of the 6SN7-GT and is a conventional 1-ma movement. A 1N34 diode is used as meter rectifier.

Tests with a Western Electric 2B measuring set and a 19-C oscillator indicated the preamplifier to be substantially flat from 50 to 15,000 cycles, which is well beyond the range over which it is expected to be used. Input-output comparison tests with a square-wave generator and oscilloscope were very favorable. Means to check distortion were not available, but listening tests indicated that the audio quality was excellent, and records made with the equipment bore out the observations.

This preamplifier was designed for use in connection with recording equipment. It can of course be used for other applications. In some situations it might be advantageous to incorporate equalization in the first stage. Thus one of the sections might be compensated for the output of a tape puller, another for a reluctance pickup, etc.

Amplification is sufficient to permit such a modification in most of the cases which would arise, and certain types of work can better be done with a unit which combines the preamplifier and equalizer in one portable case.

Materials for preamplifier:

Resistors: 4—820, 4—22,000, 2—47,000, 4—470,000 ohms, ½ watt; 4—1, 5—1.5 megohms, ½ watt; 1—470, 2—820, 1—2,200, 1—10,000 ohms, 1 watt; 1—4,700 ohms, 2 watts; 1—4,500, 1—9,000 ohms, 10 watts. Potentiometers: 1—5,000 ohms, wire-wound, screw-driver adjustment; 5—500,000 ohms.

Capacitors: (Paper) 9—.05, 4—0.5 µf, 400 volts: (Electrolytic) 6—16, 2—20, 1—40 µf, 450 volts; 6—25 µf, 25 volts.

Miscellaneous: Tubes: 4—6J7, 3—6SN7-GT, 1—5Y3-GT. 8—octal sockets; 1—1N34 germanium diode; 1—0-1-ma d.c. meter; 4—coaxial connectors, female; 4—shields for 6J7; 1—power transformer, 700 volts c.t., 70 ma, 5 volts c.t., 2 amp. 6.3 volts c.t., 4 amp; Chassis and cover; hookup wire; knobs; dial plates; hardware, etc.

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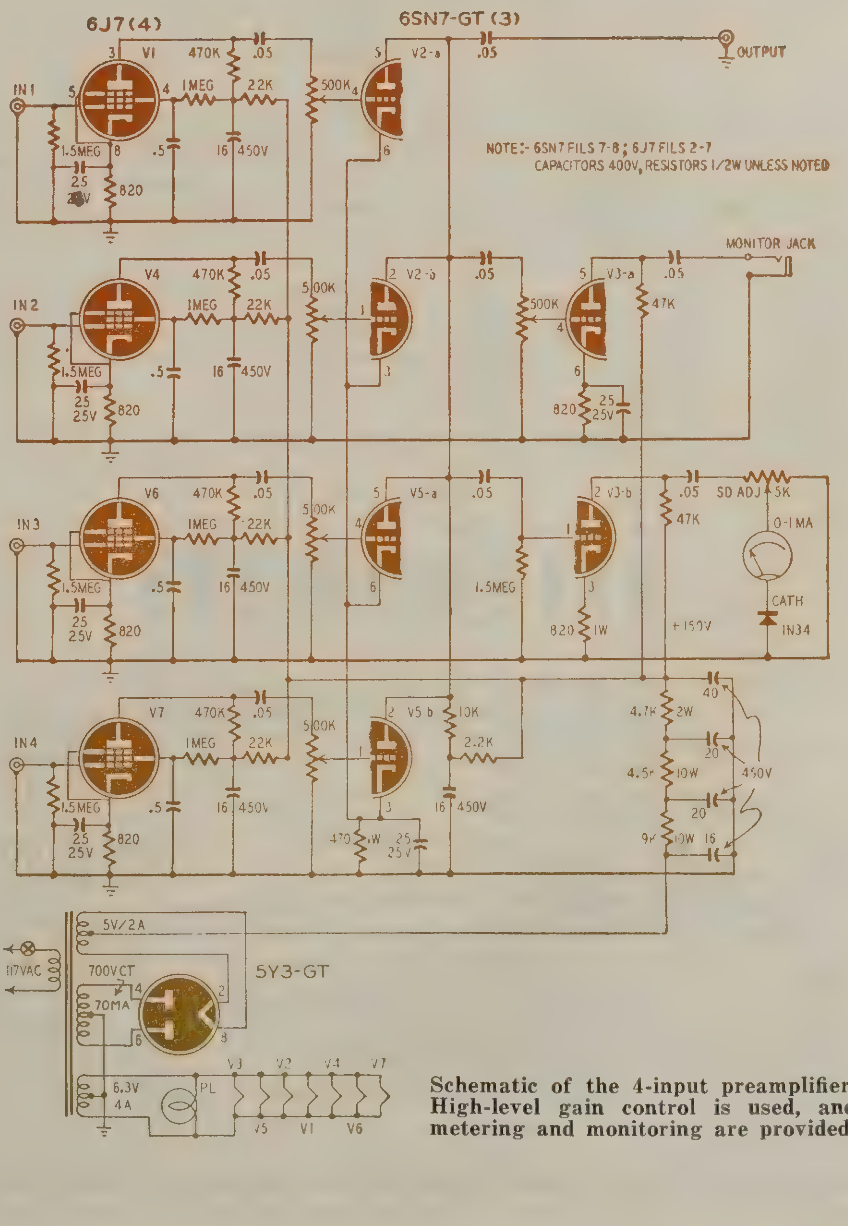


Schematic of the 4-input preamplifier. High-level gain control is used, and metering and monitoring are provided.

ELECTRONICS and MUSIC

part XVIII The Baldwin organ . . . its keying and tone color circuits

By RICHARD H. DORF

ONE of the most interesting features of the Baldwin electronic organ and one which contributes greatly to its outstanding performance is the keying system. Every designer of an instrument using continuously running tone generators—and that means all instruments with synchronized octave-generator chains of any kind—is faced with the problem of key switching.

The chief cause of the trouble is key clicks. The average voltage represented by any recurrent a.c. waveform is zero, and, unless there is another source of d.c. involved, the a.c. has no d.c. component. Keying a source of a.c. should therefore create no sudden rush of plate current in a following class A amplifier stage, since the average plate current in such a stage does not vary (ideally) with a change in input-signal level.

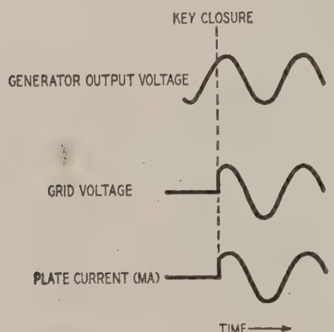


Fig. 1, left—Sudden switching of a continuous sine wave causes effects resembling those produced by square waves, with accompanying key clicks.

The fact is, however, that there is no way of knowing at what part of the a.c. cycle the key will close. And if it closes at any part of the cycle except one of the two instants when it is passing through zero, there is a sudden instantaneous change in tube plate current from its resting value to some higher or lower value. This is illustrated in Fig. 1. Note that at the instant of key closure, the plate current rises in a very short time, and the vertical line looks like the leading edge of an excellent square wave. This very short rise time is in the nature of a part of a narrow pulse containing a very large number of harmonics at very high amplitude and the result is a loud click in the loudspeaker. The noisiness of ordinary switching in electronic music is further aggravated by any dirt or corrosion on the contacts or any lack of positiveness in the contact, since either of these result in making and breaking the contact several times in quick succession, each time with a click.

The loudness of the click depends on the rise time of the plate current and the amplitude of rise. There are thus three possible solutions. The first, an impractical one, is to see that the switch closes only when the voltage is passing through zero. The second is to place a low-pass filter after the switch somewhere in the system, eliminating the high harmonics which create the click. The third method, especially good when the waveform is sharply peaked, causing high-amplitude plate-current excursions, is to use a device which acts as a volume control and closes the circuit gradually. Then the initial plate-current excursion is very small, since the initial input signal itself is very small, and clicks are inaudible, while the waveform, once it has come to maximum amplitude, is unimpaired.

A second and equally important advantage of a device of this kind is that

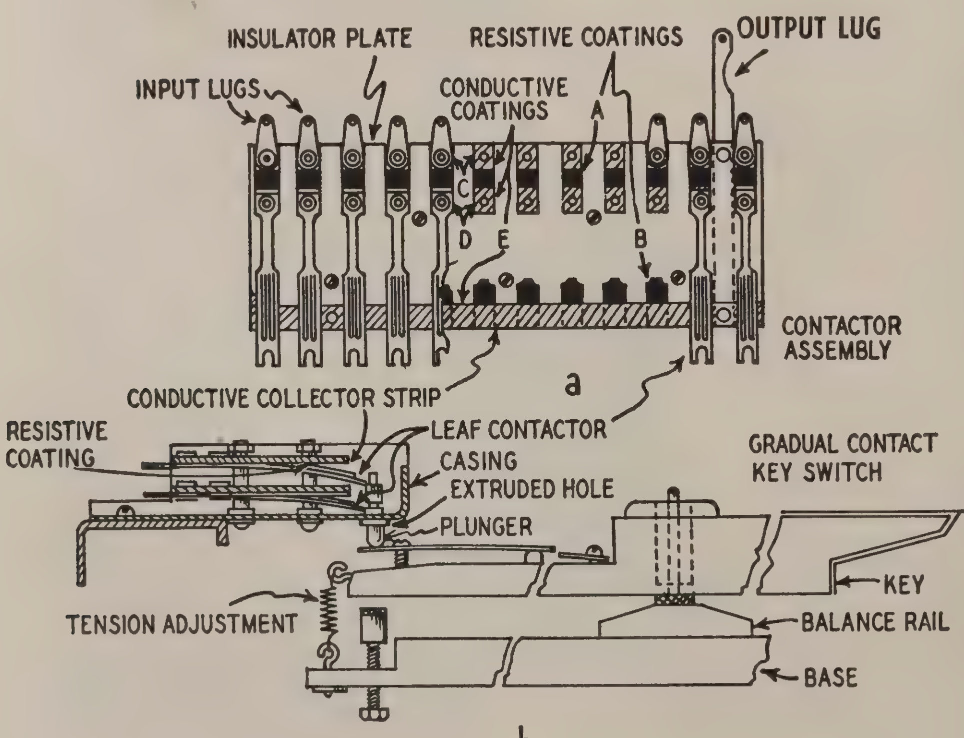


Fig. 2—In the equipment above, gradual contact is made through resistive coatings. Slow current rise eliminates clicks and produces pleasant musical attack.

it duplicates in some degree the action of conventional acoustic musical instruments, the attack of which is (except for a few plucked and struck instruments) gradual.

The special switches employed in the Baldwin for gradual attack are drawn in Fig. 2 and pictured in Figs. 3 and 4. Note first the contactor assembly at *a* in Fig. 2. This is a flat insulator plate with conductive and resistive coatings applied by printed-circuit techniques. Resistive coating A has a resistance of about 5,000 ohms. Resistive coating B has a resistance of about 25,000 ohms. A signal-input lug is fastened to conductive coating C, and one end of a leaf contactor is secured to conductive coating D. A third conductive coating E contacts all the resistive coatings B and is connected to an output lug.

The scheme is diagrammed in Fig. 5. With the silver-plated beryllium copper-leaf springs in the resting position as shown, no signal from the generator passes to the following circuits. As pressure is exerted upward on the end of the spring, the spring first contacts the left end of resistive coating B, and gradually passes along it until it contacts conductive coating E, when the circuit is complete except for the permanent 5,000-ohm isolating resistance. Under these conditions, the plate currents of any following tubes will look like the waveform in Fig. 6. The steep initial rise is still there, at point X, but its amplitude is very small and the a.c. output builds up smoothly to the maximum, as the envelope shows.

The details of the gradual-contact switch are shown in *b* of Fig. 2. There are actually 24 or 36 of them on each assembly, depending on whether the assembly is to be used in the great or swell manual. This is in two or three horizontal lines of 12 each. We shall explain the reason for the two or three groups later. The photograph of Fig. 3 shows the upper side of the key switch assembly, with the 36 input lugs (this is a 3-stack assembly for the great manual) and the 3 output lugs. The ends of the leaf contactors, with their wooden actuators, can be seen peeking from under the insulator plates at the top. The two extruded holes at the bottom are for cables. Fig. 4 shows the bottom of the assembly, with the actuator buttons coming through the extruded holes. At the left of the 12-key switch assembly is a single-key assembly consisting of two gradual switches, one above the other, used, as will be explained later, in the stop switches and for the pedal clavier.

The keying circuit

The generator assembly provides 73 tones, from the third C below middle C to the third C above middle C. Fig. 7 shows the switching schematic for the 8-foot register on one of the manuals; this means that when the middle-C key, for example, is struck, the tone switched is actually middle C, 261.7 cycles, not an octave above or below that. Since a manual includes only five octaves of keys, only five of the six octaves of tones generated are used here, octaves 2 through 6.

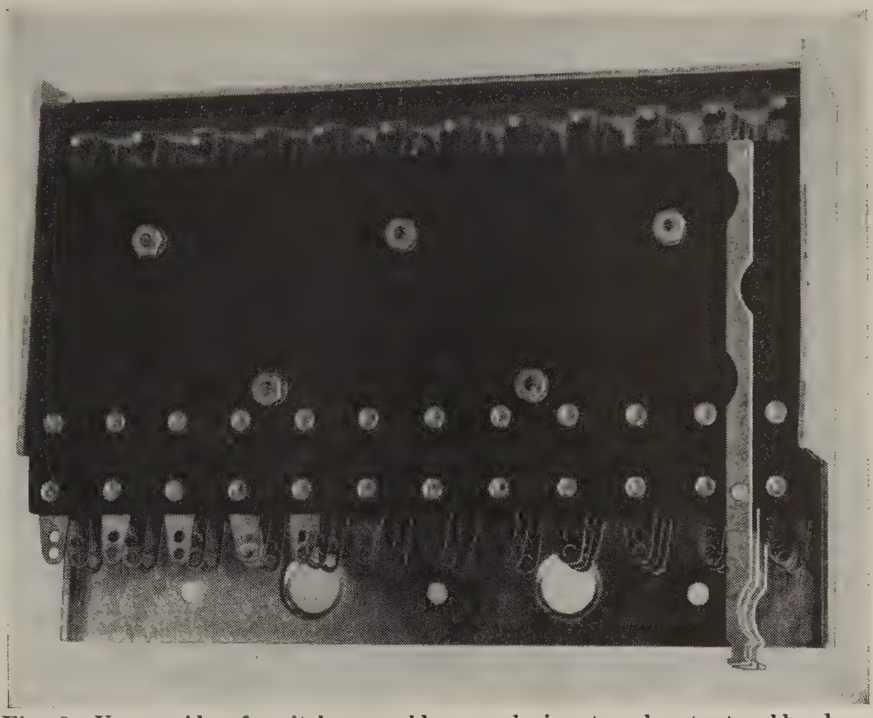


Fig. 3—Upper side of switch assembly reveals input and output solder lugs.

The tone from each generator is brought to the upper end of the 5,000-ohm isolating resistive coatings, thence to the leaf-spring contactor. Any of the tones of octave 4 which are switched in by pressing a key in that octave go to the common octave 4 collector strip. The collector strips of all the 8-foot switch assemblies go to a resistive network. The purpose of the network is to attenuate the tones from each octave in increasing degree. At the output in Fig. 7 the highest tones have the largest amplitude and the lowest tones the smallest. The reason for this will become apparent when we discuss the tone-coloring system.

Each manual has a switching system like this, each system using one bank of 12 gradual-contact switches for each octave (and a single switch for the uppermost C). The great manual has two more of these switching systems, using the other two banks of switches in its octave assemblies. One system is a 16-foot register, meaning that when middle C is keyed, the tone actually heard is one octave below middle C, and so on. The 16-foot system makes use of the tones generated in octaves 1 through 5. The third switching system is for the 4-foot register, and uses octaves 3 through 6. Since there is no seventh octave, normally necessary to provide tones one octave above the highest keys on the manual, the upper octave of 4-foot switches simply repeats the tones of

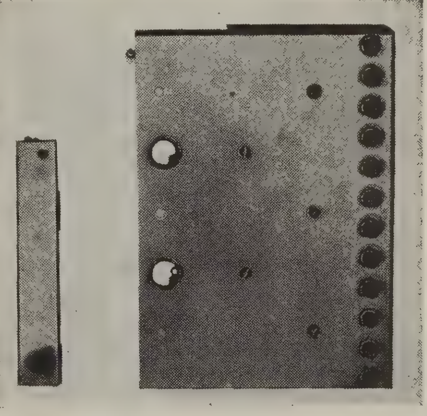


Fig. 4—A 12-note gradual-contact key switch assembly. Single switch at right.

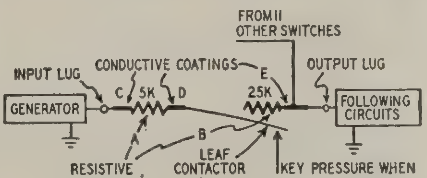


Fig. 5—Schematic diagram of switch system shows method of gradual attack.

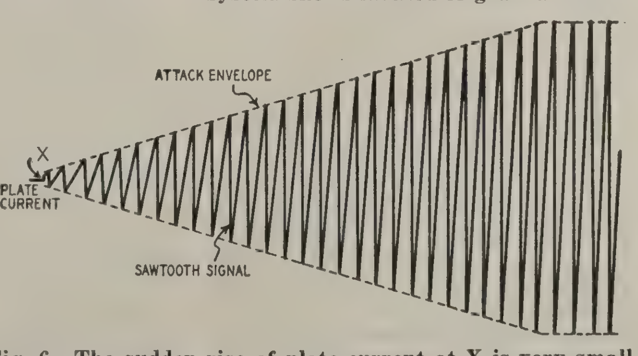


Fig. 6—The sudden rise of plate current at X is very small.

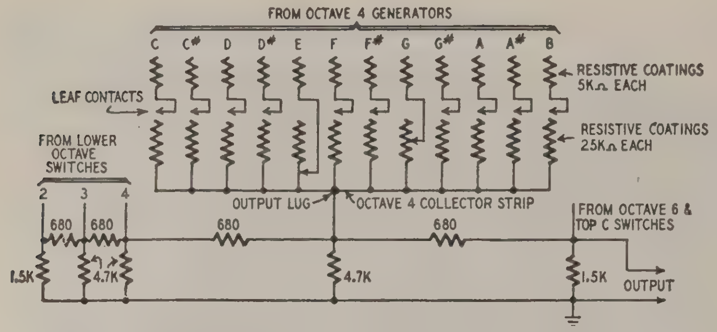


Fig. 7—Schematic of 8-foot swell or great keying system. Because output is taken from high-frequency end of attenuator network, highs predominate.

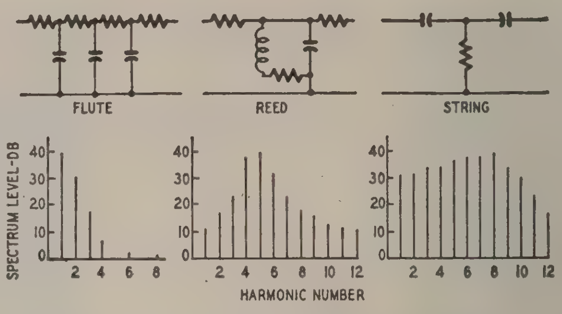


Fig. 10—Filters (above) to produce correct harmonic structure of three kinds of musical tones shown below.

the octave below in the 4-foot register.

We thus have three separate switching systems in the great manual, though all are actuated every time a key is pressed. Each system has an output so there are three outputs in all (plus an extra 4-foot output taken from the low-frequency end). The swell manual has only 8- and 4-foot registers, with a total of two outputs. The pedal clavier has only 16- and 8-foot registers, making a total of two outputs. All these outputs are fed to the tone-color box and each output provides sawtooth waves.

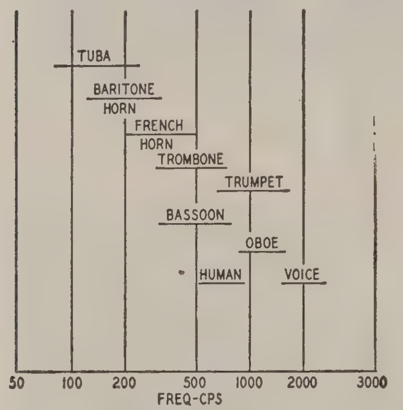


Fig. 8—Formant ranges of some typical orchestral musical instruments.

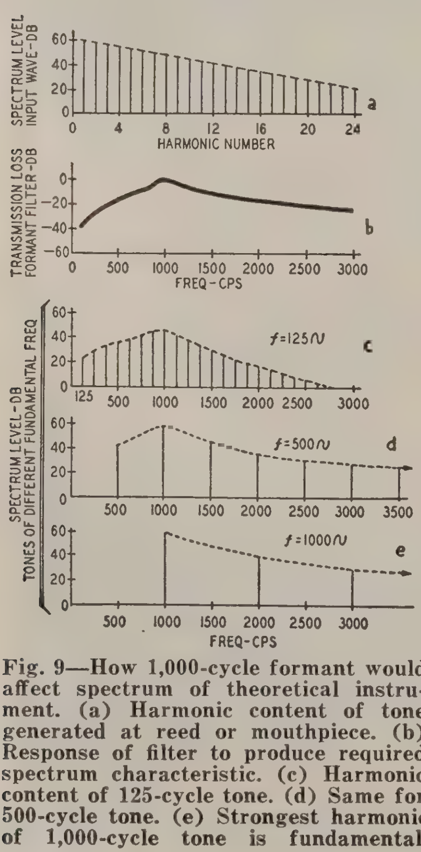


Fig. 9—How 1,000-cycle formant would affect spectrum of theoretical instrument. (a) Harmonic content of tone generated at reed or mouthpiece. (b) Response of filter to produce required spectrum characteristic. (c) Harmonic content of 125-cycle tone. (d) Same for 500-cycle tone. (e) Strongest harmonic of 1,000-cycle tone is fundamental.

Tone-color principles

The method of tone coloring in the Baldwin is built solidly on the theory of formants. A formant may be defined simply as a frequency range in which the harmonic components of a complex wave are prominent relative to the harmonics in other frequency ranges. Any tone color may have more than one formant, due to the physical properties of the instrument which produces it, as we explained in the July issue of RADIO-ELECTRONICS. The tone color as it appears to the ear is influenced not only by the formant frequency range but also by the amount of emphasis in that range and the width of the frequency band involved. Fig. 8 is a chart showing the formant frequencies of some typical instruments. The instruments in the chart all have quite pronounced formants; many others have much wider formant ranges with much less emphasis of the harmonics which fall in those ranges. The generalized difference to the ear is that the latter sound rather bland, while the instruments in the chart sound fairly sharp and are easily identified.

Notice the formant frequencies of the brass instruments; the frequency becomes higher as the size of the horn bell decreases. Note, too, the human voice as shown in the chart. The voice has two formants caused by the size and resonances of the oral cavity (not by the difference between male and female voice pitches, which is accounted for by the difference in fundamental pitch generated as the result of differences in the vocal chords). Speech is intelligible because in speaking we change the shape of the oral cavity to give different formants within the ranges shown. All vowels have a formant in the lower range and most also have one or more in the upper range.

Fig. 9 shows the effect of a formant range on the spectrum of a musical instrument. Let us assume that we wish to imitate a type of tone color whose formant is at and around 1,000 cycles. At *a* appears the harmonic content of any tone produced initially at, say, the reed or the mouthpiece. It may closely resemble a sawtooth, which means that succeeding harmonics will be present with amplitudes inversely proportional to their orders. To duplicate it, therefore, let us set up a sawtooth oscillator of variable frequency.

In *b* we see the desired bandpass characteristic of the following circuits, with a rise in response at 1,000 cycles and a drop in response at each side of 1,000. This can be achieved with a simple L-C tuned circuit of moderate Q. In *c* we see what happens when we pass a tone of 125 cycles through the system. The most prominent harmonic, due to the response of the filter, is the eighth, at 1,000 cycles.

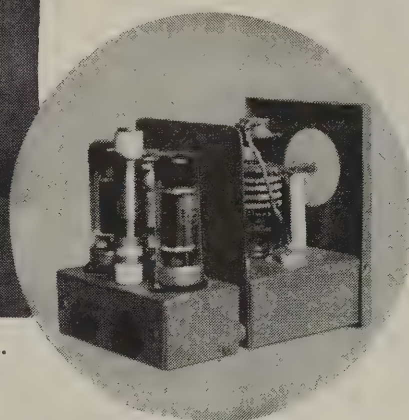
In *d* we observe what happens to a 500-cycle note—the most prominent harmonic is the second. And in *e*, with a fundamental frequency of 1,000 cycles, the most prominent harmonic is the fundamental itself.

This is a simplified example, for actually the "response curve" of the spectrum of an organ stop or other instrument does vary somewhat, depending on the fundamental frequency—the formant shifts to some extent as the instrument is played over its fundamental range. There are, however, very much larger differences between the spectra of some other instruments, so providing a single filter over the entire range of an electronic instrument makes a satisfactory approximation. Fig. 10 shows typical spectra for flutes, reeds, and strings in the octave above middle C, together with the basic electrical filters which will give the correct frequency response to imitate these spectra. In practice, the basic filters shown may be followed by others which help to produce the desired boost and rolloff characteristics. Notice the sharp dropoff in upper flute harmonics, the highly resonant character of the reed spectrum, and the much softer emphasis at the string formant. Strings in general have a number of formants.

Next month we shall complete our description of the Baldwin electronic organ with schematic diagrams of the tone filters and descriptions and diagrams of the power amplifiers and other details.

(to be continued)

IONOPHONE CIRCUITRY



Ionophone, with two views of its driving equipment.

By E. AISBERG*

and M. BONHOMME**

"YESTERDAY'S dreams make tomorrow's inventions."

To couple yesterday's dream with future reality, it was necessary to strike out into new and unexplored areas—to do things as they had never been done before. Thus the young French physicist Klein found it advisable to abandon the whole audio amplification system and excite the speaker described in last month's article with *modulated radio-frequency* waves.

The high-frequency, high-voltage oscillator used to excite the speaker, and which can be modulated by a low frequency, is shown in our schematic, Fig. 1. A form of plate modulation is used. Grid modulation could, of course, just as well have been used, or any of the standard modulation systems.

We have a small transmitter of classical design except for the output, which is through a high-ratio r.f. transformer, to obtain the necessary high voltage. The 40-meg resistor in shunt with the secondary of the transformer serves to damp out peaks. It is made of a small plastic rod, with a diameter of about ⅜ of an inch and is about 8 inches long.

The power produced by the prototype here described is equal to that of an electrodynamic speaker rated at around 10 watts. The response curve (Fig. 2), which is the result of tests made by the Centre National d'Etudes des Telecommunications, shows its wide range. As a matter of fact, it can reach much higher frequencies. However, its output diminishes in the supersonic range because the transit time of the ions becomes an appreciable quantity in relation to the oscillation cycle.

Its acoustic output (the relation of the low-frequency electrical energy and the acoustical energy measured in a soundproof room), is 7%—much higher than the better type of present electrodynamic loudspeakers.

The special characteristics of this new loudspeaker suggest interesting possibilities. Though it can be used in conjunction with present-day radio receivers without any modification, it may be predicted that the future will see sets specially adapted to the new loudspeaker. Receivers may even be designed *without detection stage*, but with the intermediate frequencies, adequately amplified, serving as the source of excitation for the loudspeaker. Elimination of the detector stage, which is a source of distortion, would be a great advantage. At the same time, a special oscillator as a source of high-frequency excitation for the speaker would no longer be needed, as the modulated i.f. would fit the specifications exactly. However, there are certain difficulties to be overcome before such a receiver can be created.

Aside from use in the radio, an interesting application of the ionic loudspeaker might be made in the field of supersonics. Of all the known supersonic transducers (piezoelectric, magnetostrictive, etc.), it is the only one that is aperiodic and which can with equal ease generate all the supersonic frequencies and frequency-modulate them.

It should not be overlooked, on the other hand, that all electrical phenomena are reversible. Like all other loudspeakers, the ionic model can be used also as a *microphone*. Sound waves penetrating to the vicinity of the cathode disturb the movement of the ions and thus modify the electrical resistance of the ionized space. Thus we have a microphone with variable conduction, comparable, in a certain measure, to the carbon microphone.

However, it is not safe at present to predict the practical realization of such a microphone, as the background noises due to the irregular flow of the ions—hardly perceptible when the device is operating as a loudspeaker—would act the same in a microphone, but would also be amplified in all the successive stages which follow the microphone and might reach a quite disturbing level.

It is still difficult to foretell all of the applications that the future may hold for the Ionophone. It is within the realm of possibility that therapeutic uses might be discovered. The possibility of simultaneously producing supersonics of controllable frequencies and intense ultraviolet rays modulated by the same frequency might be of great value. Meanwhile researchers have before them a new and fertile field of investigation.

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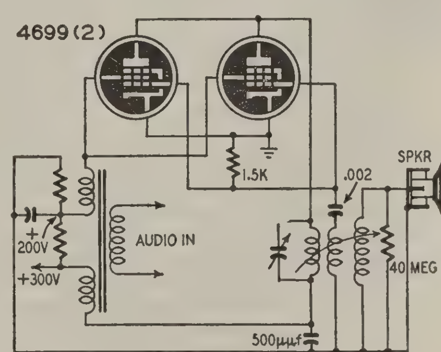


Fig. 1—The Ionophone driving circuit.

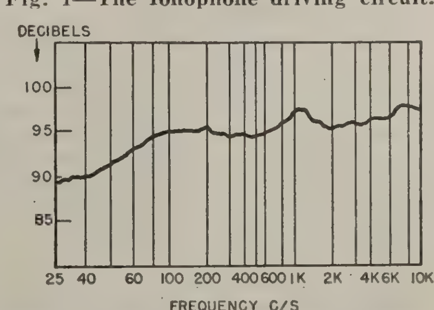
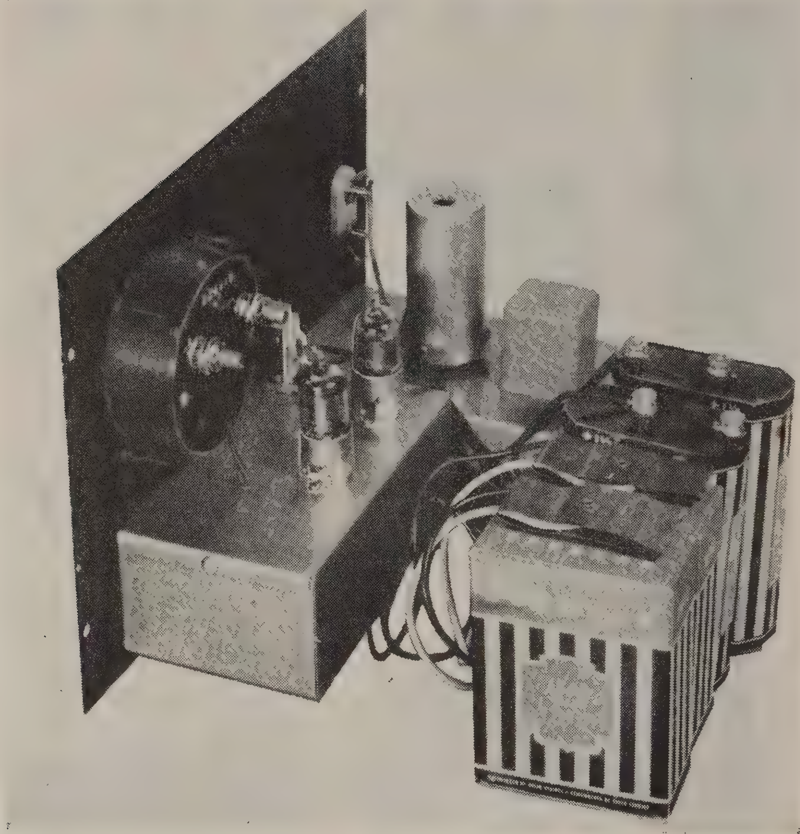


Fig. 2—Response curve of the speaker.

*Publisher of *Toute La Radio*, Paris
**Chief Editor of *Toute La Radio*

MEASURING



Distortion meter. Audio inductor and plug-in tuning unit are seen at rear.

ONE of the most important considerations in appraising amplifier performance is how faithfully the system transmits audio impulses. Only distortion measurements can establish quantitatively the degree of fidelity.

Distortion tests enable the designer to check the effects of circuit changes on reproduction. They are invaluable also to the service technician in determining the effectiveness of repairs and adjustments. In routine maintenance work, the sudden appearance of small amounts of distortion, usually not detectable by ear, usually points to the start of trouble in some component.

Testing methods

There are several methods of measuring audio distortion. Of these techniques, the fastest, as well as the one most favored in service and maintenance, is that of checking *total distortion.* The technician usually is not as much interested in the strength of separate distortion components (for example, second harmonic, third harmonic, fourth harmonic, etc.) as he is in the answer to his question, "How *much* distortion is present?" Furthermore, there seldom is time to check individual harmonics and to calculate the square root of the sum of their squares when distortion must be checked after each of many amplifier adjustments.

A widely-used basic distortion-measuring circuit is shown in Fig. 1. This is the bridged-T network which is the foundation of the distortion meter described in this article. The network components (L, C1, C2, and R) are chosen to provide a sharp null (zero transmission) at the test frequency. R is made variable and is preset closely for sharp null. When the Q of the circuit is kept reasonably high, the fundamental test frequency is eliminated completely and only the total harmonic voltage (E2) appears across the a.c. millivoltmeter. In use, the amplifier or audio network to be tested is supplied with a signal from an audio oscillator or signal generator having very low distortion. The output of the amplifier then is connected to the input terminals of the network. The meter is switched first across the network input terminals, as shown by the dotted lines, to read the amplifier output voltage (E1). This voltage contains fundamental and harmonics. The meter finally is switched to the output of the bridged-T network, and the small voltage (E2) due to harmonics is read. The distortion then is the ratio of E2 to E1 and is expressed in percentage as 100 (E2/E1). If the input voltage, E1, always can be set to a predetermined level for reference, the millivoltmeter can be made direct reading in distortion percentage, and no calculations will be required.

Complete instrument

Many amateurs and professionals have employed this method of distortion measurement, using homemade equipment. However, there are several difficulties common to almost all setups: (1) The a.c. meter must be capable of checking very small voltages at the output of the bridged-T network. These often are millivoltages which cannot be read on the scales of ordinary v.t. voltmeters. For example, 1 volt may be obtained from the amplifier under test and applied to the input terminals of the distortion-checking circuit. In order to measure 1% distortion, the meter then must show 10 millivolts (0.01 volt) when connected to the bridged-T output. (2) Coil L (Fig. 1) must have a higher Q than customarily is obtainable with the power-supply filter chokes often used in the circuit by experimenters. If the Q of the bridged-T circuit is not high, harmonics will be attenuated and the meter will not give a true indication of distortion. (3) Usually, no provision is made for easily changing the operating frequency to a new value. (4) Considerable inaccuracy can occur from hum generated by the power supply of the v.t.v.m. and picked up by the bridged-T choke.

We have made the following improvements to remove these shortcomings: (1) A sensitive electronic millivoltmeter circuit has been provided. This circuit requires no zero adjustment. The indicating meter is a comparatively inexpensive 0–1 d.c. milliammeter (reading linearly direct in distortion percentage—1, 10, and 100% full scale), and only 10 millivolts at the output of the bridged-T network is required for full-scale deflection when the range switch (S2 in Fig. 2) is in its 1% position. (2) Hum has been eliminated by powering the voltmeter

DISTORTION

By RUFUS P. TURNER

Service technicians as well as high-fidelity men need a quantitative means of checking distortion; it is one of the two commonest faults in receivers

circuit with small, self-contained A- and B-batteries. Since the drain is low, long battery life may be expected. Battery operation also provides complete isolation. (3) Coil L is a special audio inductor (U.T.C. type VI-C15) which has good Q and adjustable inductance. (4) The test frequency may be changed at will with plug-in frequency units C1, C2, R1. The values given for C1, C2, and R1 in Fig. 2 are for a test frequency of 400 cycles, since this frequency is supplied by most AM signal generators. Table I gives capacitance and resistance values for other common test frequencies between 50 and 5,000 cycles. There is little point in checking beyond 5,000 cycles, since the harmonics of higher frequencies lie out of the range of most hearing. Usually, three test frequencies, selected in the low, middle, and high portions of the audio spectrum (e.g. 50, 1,000, and 5,000 cycles), will give a satisfactory practical picture of amplifier behavior. The author found it convenient, for compactness and simplicity, to use plug-in frequency units. However, the reader, if he desires, may incorporate a switching "tuner" and enclose all components for 10 or more frequencies within the instrument case.

The complete circuit is shown in Fig. 2. The input gain control allows the meter to be set to a reference level (such as 100%) when the meter is switched to read input voltage. Switch S1 is a spring-return switch resting normally in the position shown, to connect the meter across the output of the bridged-T network. For initial adjustment, this switch is thrown to the right to connect the meter to the input.

The range switch, S2, gives the indicating meter three ranges—0–100%, 0–10%, and 0–1%. At the 100% setting of the switch, the meter has a full-scale deflection of 1 volt, at the 10% setting 0.1 volt, and at the 1% setting 0.01 volt.

The millivoltmeter circuit is simple, employing a high-gain 1U4 pentode resistance coupled to a triode-connected 3S4 driver amplifier for the meter circuit. The full-wave meter circuit consists of a crystal bridge employing two 1N34 germanium diodes and two 100-ohm resistors. If a pair of matched 1N34's aren't available, use a 1N35 duo-diode. The 100-ohm resistors must be matched within at least 1%.

Since the 3S4 must be cathode-biased, the A-battery must be operated above ground. That is the reason for the separate A-battery for the output stage. There is no B-battery drain when the tube filaments are not lighted, so no switching is needed in the high-voltage circuit.

Construction details

The photographs show construction details of the distortion meter. The instrument is housed completely in a 10 x 7 x 8 inch standard metal cabinet. Tuning and millivolt-amplifier units are mounted on separate small box-type chassis. The chassis holding the amplifier measures 5¼ x 3 x 2 inches. The tuning unit chassis is 5½ x 3 x 1¼ inches. Both of these chassis are enclosed on all sides and accordingly provide good shielding.

On page 34, small, shielded inductor L may be seen on the rear of the farther chassis. Directly in front of the inductor is the plug-in can containing C1, C2, and potentiometer R1. The latter is provided with a slotted shaft for adjustment through the hole seen in the top of the plug-in can. The plug-in foundation is a Millen 74001 assembly which has an octal base. The coil form is removed from this unit and the two capacitors and potentiometer are installed in its place. In order to fit into the small can, Mallory *Midgetrol* potentiometers (15/16 inch diameter) were used. If the reader is compelled to use larger potentiometers, the larger Millen 74400 plug-in cans may be employed. The latter are rectangular cans and, like the type 74001 used in our instrument, are provided with octal bases for plugging into a standard 8-pin tube socket.

The A- and B-batteries fit snugly into the cabinet just to the rear of the amplifier chassis in approximately the position they are shown in the first photo. They stand vertically.

The leads from the input binding-post terminals are shielded with braid.

Keep all leads in the meter amplifier as short as possible and use point-to-point wiring. Resistors R2, R3, and R4 must be of close tolerance, varying not

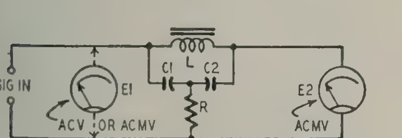


Fig. 1, above—Basic distortion meter circuit. It is the familiar bridged-T.

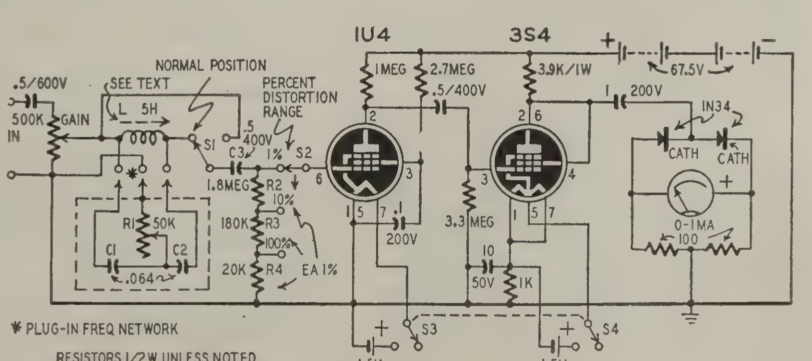


Fig. 2, right—Schematic of a distortion meter which combines sensitivity, low hum level, complete suppression of the fundamental signal and ability to operate on several audio frequencies.

more than 1% from specified values. Aside from these points, no special precautions are necessary in construction of the amplifier. In the plug-in units, capacitors C1 and C2 must be matched carefully and should be as close to specified values (see Table I) as can be obtained. A glance at the list shows that a number of the capacitances are not stock values, but must be made up with suitable units connected in parallel (e.g., 0.028 µf required for the test frequency of 600 cycles would be made by paralleling 0.02 and 0.008). These capacitors must be high-grade, to insure high Q in the bridged-T network. By using metallized tubulars for the high capacitances, smallest physical size may be secured.

TABLE I
PLUG-IN BRIDGED-T NETWORK COMPONENTS

Test Frequency (cycles)	Capacitors C1, C2 (µf each)	Potentiometer R1 (ohms)
50	4	10,000
100	1	10,000
200	0.250	50,000
300	0.11	50,000
400	0.064	50,000
500	0.04	100,000
600	0.028	100,000
700	0.020	100,000
800	0.016	100,000
900	0.0125	100,000
1000	0.010	500,000
2000	0.0025	500,000
3000	0.0011	500,000
4000	0.00064	2 meg.
5000	0.00040	2 meg.

Initial adjustment

If the instrument has been wired correctly and good components used throughout, the voltmeter section will require no adjustment whatever. However, if desired, this part of the instrument circuit may be checked for voltage calibration and linearity. Remove temporarily the lead between C3 and S1 and feed a series of accurately known calibration voltages between C3 and ground, checking the corresponding meter readings. A 1,000-cycle source, such as an audio oscillator, is recommended. In some instances, higher sensitivity might be obtained—full-scale deflection with less than 10 millivolts input with switch S2 at 1% position. However, the absolute voltage level is unimportant in this application. The important thing is that the voltage, whatever its level, be divided *exactly* by 10 and 100 by successive settings of switch S2.

Next, the frequency units must be adjusted to the corresponding operating frequencies. We will give one example, that of the 400-cycle unit. (1) Switch on the distortion meter and allow about 5 minutes warmup time. (2) Set an audio oscillator to 400 cycles and connect its output to the distortion-meter input terminals. (3) Plug the 400-cycle frequency unit into the distortion meter. (4) Set switch S2 to its 100% position and advance the gain control until a healthy meter deflection is obtained. (5) Adjust potentiometer R1 in the frequency unit for lowest obtainable meter reading (complete null). (6) With an 8–32 Allen wrench, adjust the inductance set-screw in inductor L for further improvement of this null. (7) Do not touch the setting of R1 at any time afterward unless a routine recalibration is made. Also, do not retouch the setting of the inductance screw in the inductor L. (8) Successively plug in each frequency unit and adjust it to its particular frequency by adjustment of its potentiometer R1 only.

Operating the meter

Checking oscillator distortion: After warming up both the oscillator and distortion meter for at least 5 minutes, connect the oscillator to the distortion meter and set the oscillator output to the desired level. (1) Set switch S2 to its 100% position. (2) Plug-in a frequency unit for the desired test frequency and set the oscillator dial to that frequency. (3) Set switch S1 to its right-hand (input) position and adjust the gain control for full-scale meter deflection. (4) Return switch S1 to its normal (output) position. (5) Set switch S2 successively to lower ranges until an accurately readable meter deflection is obtained. This deflection, together with the setting of switch S2, will indicate the oscillator distortion percentage directly. (6) Rock the oscillator dial back and forth slightly for an improvement in the meter dip. (7) Repeat the procedure at several settings of the oscillator output control, since oscillator distortion often varies with output.

Checking amplifier distortion: Measuring the distortion of an amplifier is similar to the procedure just given for checking an oscillator. There is an important preliminary point, however, and that is to check carefully the distortion of the oscillator which is to be used to supply a test signal to the amplifier. The oscillator distortion figure then must be subtracted from any distortion figure obtained for the amplifier. When checking a complete amplifier system, connect the distortion meter across the loudspeaker voice coil (if you can stand the noise), since the speaker is the normal load of the amplifier. If quietness is a necessity, however, the voice coil may be replaced temporarily with a resistor having the same ohmic value and rated at twice the power output of the amplifier.

To check the amplifier: (1) Connect a low-distortion audio oscillator (whose distortion has been checked and recorded at each intended test frequency) to the amplifier input. (2) Connect the amplifier output to the distortion meter. (3) Allow the oscillator, amplifier, and distortion meter to warm up. (4) Plug-in a distortion meter tuning unit for the first test frequency. (5) Set the oscillator to the same frequency. (6) Set switch S2 to its 100% position. (7) Set switch S1 to its right-hand (input) position, set the amplifier gain contro to the desired test point, and advanc the gain control of the distortion mete for full-scale meter deflection. (8) Re turn S1 to its normal (output) positio and change the setting of switch S2 fo a readable meter deflection. (9) Rock the oscillator dial to deepen the null (10) Read the distortion percentag from the meter deflection and the set ting of range switch S2. (11) Subtrac from this figure the distortion of th audio oscillator, previously determined (12) Repeat the procedure at as man test frequencies and at as many set tings of the amplifier gain control a desired.

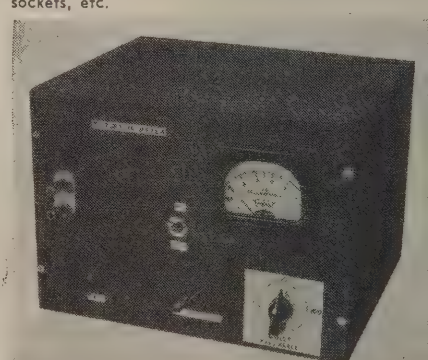
Special note regarding low test volt ages: When the amplifier or oscillato under test delivers an output voltage o 1 or higher, the distortion meter ca be set initially to 100%. Under thi condition, 1% distortion then can b read at full scale when the range switc is at its 1% setting. On the sam range, the first major division of th meter scale (0.1 milliampere) indicate 0.1% distortion, and the first smal division 0.02% distortion. If the tes voltage is lower than 1 volt but suffi cient to allow the meter to be set to ful scale with switch S2 in its 10% positio then 10% distortion is indicated at ful scale when S2 is switched to its 10% position. When the test voltage is to low to permit setting the meter to ful scale, simply divide the final indicate distortion figure, indicated by the meter by the distortion indicated in the initia setting. Example: With switch S2 a its 100% setting, the meter can be se initially only to the 50% point. In th distortion measurement, with S2 sub sequently set to its 1% position, th meter indicates 0.5% distortion. Th true indicated distortion then is 0. divided by 50, or 1%.

Materials for Meter (400 cycles)

Resistors: 2—100 ohms, ½ watt (matched withi 1%); 1—1,000 ohms. ½ watt; 1—3,900 ohms, 1 wat 1—1, 1—2.7, 1—3.3 megohms, ½ watt; 1—20,00 1—180,000 ohms, 1%, ½ watt; 1—1.8 megohms, 1% ½ watt. (Potentiometers) 1—500,000 ohms; 1—50 000 ohms (Mallory U33).

Capacitors: (Electrolytic) 1—10 µf; 50 volts. (Minia ture metalized tubular 2—.06, 2—0.5 µf, 400 volt 2—1.0 µf, 200 volts; 1—0.5 µf, 600 volts. (Mica) 2- .004 µf.

Miscellaneous: 1—Adjustable inductor (UTC V C15). Batteries: 2—67.5 volts, Burgess XX45 or equiva lent; 2—1.5 volts, Burgess 2FBP or equivalen Switches: 1—s.p.d.t., spring-return rotary; 1—single circuit, 3-position, non-shorting. Meter: 1—0–1-m d.c., Triplett 327-T or equivalent. Chassis; cabine dial knobs; input terminals; hookup wire; tube sockets, etc.



A front view of the distortion meter

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Uses for the 6BN6

By WILBUR J. HANTZ

HERE are three ways of using the 6BN6 gated tube. Fig. 1 is a circuit that can be used either for revamping an existing TV receiver or for new set construction. The sound portion here is a modification of the one used in Zenith TV receivers. Standard available parts are used throughout. Alignment is simple in comparison to the ratio detector or discriminator which is used in most intercarrier TV receivers. A 4.5-mc AM signal is fed into the grid of V1 and the slugs of L1, L2, L3, are adjusted for best response. The buzz control is adjusted for the least intercarrier modulation hum.

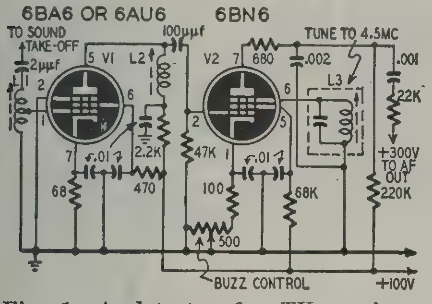


Fig. 1—A detector for TV receivers.

The circuit in Fig. 2 is suggested for an FM receiver, using the 6BN6 as a limiter, discriminator, and first audio amplifier. Alignment is much the same as any FM receiver, and the quadrature coil is also adjusted at the intermediate frequency. A conventional FM i.f. primary can be used. The 500-ohm linear control is adjusted for best limiting or the least amount of noise.

Due to the unconventional characteristics of the 6BN6, it can also be used as a sync separator or square-wave generator. When the control-grid voltage swings in a positive direction, the plate current rises sharply from zero to a peak maximum. When the grid voltage swings in a negative direction, the plate current drops abruptly to zero. Therefore, the first grid controls the plate current in steps.

The action of the quadrature grid (second control grid) is similar. If it is biased negative, the plate current drops to zero. Within a small range between negative and positive it can control the plate-current peak. If made too positive, all control is lost.

Fig. 3 is a clipper or squarer for a sine wave. The peak clipping level is adjusted by the control in the cathode circuit. This circuit can also be used for clipping noise peaks in AM receivers.

Many other uses for the 6BN6 will suggest themselves. For instance, it could also be used as a keying tube. If negative keying pulses were applied to the second control grid the tube would then be an electronic gate. The 6BN6 could also be used as keyed automatic gain-control tube in TV receivers instead of the 6AU6 which has been used by several manufacturers.

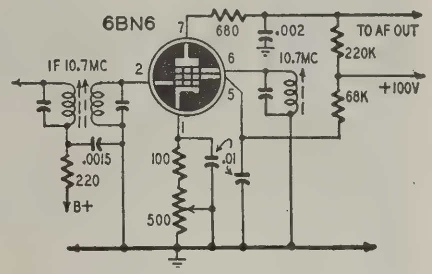


Fig. 2—Limiter, detector, and audio.

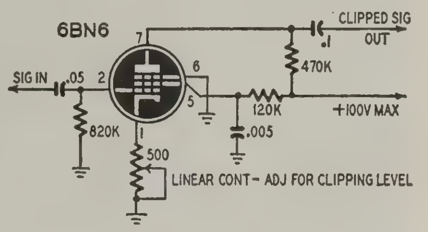


Fig. 3—A square wave clipping circuit.

Materials for FM Sound Unit

RESISTORS: (All ½ watt) 1—68, 1—470, 1—2200, 1—47,000, 1—680, 1—100, 1—68,000, 1—220,000, 1—22,000 ohms.
CAPACITORS: (Gimmick or ceramic) 1—2 μμf. (Paper) 5—.01, 2—.002, 1—.001, 1—.005 μf 400 volts. (Mica) 1—100 μμf 300 volts. (Electrolytic) 1—20 μf 450 volts, 1—50 μf 25 volts.
COILS: 1—Cambridge Thermionic 5-mc peaking coil (L2), 1—4.5-mc intercarrier sound trap (L1), 1—Primary of discarded 4.5-mc ratio detector coil, or the original one in the intercarrier set (L3).
MISCELLANEOUS: Tubes: 1—6AU6, 1—6BN6. Sockets, hookup wire, solder, hardware, chassis, etc.

Parts List for Clipper

RESISTORS: 1—820,000 ohms, ⅛ watt; 1—120,000 ohm, ¼ watt; 1—470,000; ⅛ watt; 1—potentiometer, 500 ohms.
CAPACITORS: (Paper) 1—.05 μf, 1—.005 μf, 1—.01 μf, 400 volts d.c.
MISCELLANEOUS: Tubes; 1—6BN6 and socket. Hookup wire, solder, hardware, chassis.

—end—

A Question for the Technician

By NICHOLAS B. COOK

A WISE man learns from his mistakes. The most important lesson I have learned from my mistakes is that I *can* make mistakes. Consequently, after I have done a repair job that should have been right but turns out to be something else, I ask two questions:

1. *What* is wrong?
2. What did *I* do wrong?

The first question can usually be answered quickly:

"The circuit worked before. It can be made to work now."

Then the second question becomes: "I did something wrong. What is it?"

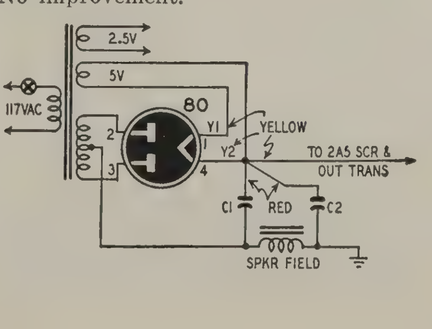
Recently I replaced the power transformer in an early 6-tube superheterodyne. As usual, I made a careful sketch of the connections. (See diagram.) I also changed the old electrolytic filter capacitors. When I turned the set on, there was a strong hum.

The hum seemed to be general (not confined to a single stage). There was tunable hum. There was hum in the output stage alone.

"What is wrong?" The capacitors were new, of best quality, and 16-μf jobs instead of the original 8-μf. The transformer was a "bargain special" but it looked good and had been carefully checked before being wired in. Rectifier tube? Replacement made no difference. A ground somewhere? More filtering? No help.

The sure way to locate hum is to trail it with the oscilloscope. This hum wore no disguise. It was pure 60-cycle sine wave. I could not even find the sawtooth pattern (120-cycle) except as a faint modulation of the sine wave.

Could something in the circuit have changed? Center-tapped resistor perhaps? All O.K. Try changing the 47 to a 2A5; the socket is defective anyway. No improvement.



There was hum across the output transformer. There was hum across the speaker field when the rectifier tube was out of the socket. Orientation of new transformer? Necessary in some cases but not in such a simple layout.

Long before this, I should have admitted: "I did something wrong. What is it?"

At last it began to dawn on me: "This is a hum that I engineered into the circuit myself. I'm picking up 60 cycles with a trick hookup." I searched and I saw. I had made a mistake again.

The chassis was crowded, the wires were bunched, there were several leads of the same color. It was easy to make a mistake. But inexcusable. Easy but incredible.

"What did I do wrong?"

Answer:

Maybe the job was so simple that I expected the wires to go in of their own accord. Maybe I was tired. Maybe I was blind. But I had connected the positive (red) wire of C2 to filament terminal Y1, putting the rectifier's 5 volts pure a.c. into my filter system!

—end—

carrying case for home service

Figs. 1 and 2—Dimensional diagram. Compartment at left holds tubes, equipment; cover section carries tools and data.

By ANDREW E. JACKSON

HOME servicing—unpopular in the past—is increasingly becoming necessary because of television. The technician can do many jobs in one trip with a representative selection of radio parts and tools, which can be carried in the case to be described. If the model number of the set is known (from previous servicing records or from inquiry to the owner) practically all service needs may be anticipated. Service data can be carried in the book rack. Home servicing becomes more efficient and profitable.

The carrying case is 20½ inches wide, 19¼ inches high, and 10 inches deep. It will hold a volt-ohm-milliammeter, signal generator, signal tracer, substitution tester, soldering iron, tools, books, 40 GT or metal tubes, and most of the other parts needed for radio and TV servicing. Weight is only 15 pounds empty. Cost is about five dollars. The design is extremely flexible so that, while primarily for the service technician, the case makes a complete workshop for the amateur or experimenter.

Fig. 1 shows the various compartments in the case. The signal-generator compartment will hold most of the smaller size AM or FM models, including the RCA line. (It also makes an excellent place to carry demonstration receivers.) The drawer serves as a holder for all small parts and will hold 20 additional tubes, if desired. A large, heavy cloth upon which to lay parts and tools also may be carried. Fig. 2 is the inside of the door. A hacksaw is mounted on right-angle hooks behind the tool rack, which is removable. The signal-tracer compartment is made for a tracer probe of the crystal-diode type which can be used with a pair of headphones. The headphones are mounted in the test-lead compartment which is behind the volt-ohm-milliammeter compartment. The parts, test unit panels, books, etc. are accessible by opening the door which covers the front of the case. Test equipment, test leads, and headphones may be removed by opening the top lid.

The case is made of quarter-inch plywood because it is inexpensive, requires a minimum of tools, and has much more strength for its weight than regular wood. Saw crossgrain cuts slowly and carefully to avoid chipping the wood.

Assemble the parts of the case as shown in Figs. 1 and 2 according to the general rules given below. Check with the photos. All joints of the construction are glued, and are reinforced with nails wherever possible. Parts should be fitted together temporarily to determine where glue and nails go. When nails are used, space them evenly, driving them from the side opposite that from which glue will be applied and until their points are seen on the surface which will be glued. Then apply glue, fit the glued surfaces together, and drive the nails all the way in.

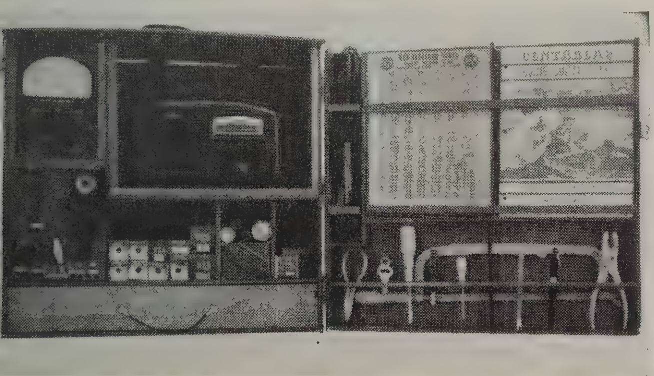
Figs. 1 and 2 show inside dimensions of compartments. The double solid lines on these figures should be drawn on the inside of the back and door front respectively as a guide for spreading glue. Draw light pencil lines, as a guide for driving nails, on the outside of the back so that they fall between double lines (given dimensions plus ⅛ inch).

Start construction by fastening the ends to the end edges of the bottom so that the pieces are perpendicular to each other. The back then may be secured to the unit just made. Now the

pencil lines previously drawn on the back may be extended to the sides to aid in assembling the shelf and the bottoms of the test-equipment compartments. Drive nails into the sides of the shelf first to hold it in place while driving nails into the back.

Draw parallel pencil lines 8 and 8¼ inches down on the multimeter side of the partition to aid in gluing the partition to the multimeter compartment bottom. Where the partition joins the bottom of the signal-generator compartment use a 1½ x 1½-inch right-angle bracket for reinforcement. Drill 3⁄16-inch holes for the bracket in the partition and the compartment bottom 1¼ inches from their front edges. Insert bolts with their heads inside the signal-generator compartment. Place the bracket *outside* the compartment. Another bracket holds the partition to the back of the case. Bolt it on the volt-ohm-milliammeter side of the partition with the bolt nuts facing in.

The back of the multimeter compartment is the front of the test-lead compartment as shown in the top view photograph. Draw two parallel lines for glue, as before, placing the first one back from the front of the case the thickness of the instrument which will occupy the space plus a quarter of an inch. Finish the multimeter and signal-generator compartments by installing facing strips to the outer quarter inch of their sides and bottoms. Install the lower strips first. Corrugated cardboard, if placed around the multimeter and signal generator, will cushion these instruments against damage.



The carrying case and its contents are ready for a job.

Draw the proper parallel lines on the shelf to aid in gluing its partitions in place.

Fasten the side of the signal-tracer compartment perpendicularly to the outside edge of its bottom. Then fasten this unit to the rest of the case.

The door sides and bottom are assembled to the front just as was done for the main part of the case. Space and drive nails very carefully into the front to avoid denting the wood. Fasten the tool rack holders to the door sides and screw the right-angle hooks for the hacksaw into the door front slightly less than a quarter of an inch. Then the tool rack, after being drilled with various sized holes for tools (use two ½-inch holes 1 inch apart for pliers), is set on its supports so as to be easily removable when the hacksaw is needed. If necessary, brace the tool rack with a 3¼ x 1-inch plywood piece to prevent sagging. Use glue only in fastening the bottoms of the book rack and soldering iron compartment and their partition to the door front. Secure the fronts of the soldering iron compartment and the book rack flush with the front edges of the door sides and partition to complete the door.

Begin constructing the drawer by fastening its front and back outside its bottom as was done for the sides and bottom of the case proper. Make the front and back extend ¼ inch farther to the right (front view) than the bottom and the end to allow space for door bolts, making cutouts in the drawer front where necessary to pass them. Space drawer partitions as desired. After the glue has dried, rub the sides and bottom of the drawer with beeswax or soap to make it slide easily. A drawer pull may be made by screwing ⅜-inch screw-eyes into the drawer front 1½ inch from the drawer bottom and 7 inches from each end. Connect the screw-eyes with hookup wire.

In fastening the top to the case, drill 3⁄16-inch holes in the top ⅜ inch from its back edge and 3½, 4½ and 9¾ inches from each end. Drill holes in the back ⅜ inch from its top edge and the same distances from each end. (The ⅜-inch dimension will vary—check your hinges.—*Editor*) Bolt one half of each of the three hinges to the outside of the back with the bolt heads and hinge pins facing outside the case. The other halves of the hinges are bolted to the inside of the lid. Bolt heads and washers for these go outside the top as shown in the top view photo.

Drill 3⁄16-inch holes for the door hinges in the right side of the case and the right door side (front views) ½ inch from their front edges (again depending on the hinges—*Ed*) and 2½, 3½, 9 and 16½ inches from the top edge of the case. Places where holes are not drilled because of interference with shelves may be filled with screws. Place hinges and bolt heads outside the case.

The hasp on the left side of the door and its associated eye on the left side of the case should hold the door tightly to the case proper. Fasten the hasp to the outside of the case with screws. The hasps fastening the top to the sides of the case are placed 2¼ inches from the front with the hinge on the top and the eye on the side of the case. Notch the eyes of the hasps with a file so that they will hold their hinges without a padlock.

A special feature of the case is the right-angle bracket and eye fastener on the door and top. This combination holds much of the case's weight and

The test leads are reached from the top.

acts as a safety feature because the top can't be opened unless the door is open. When the door is closed the bracket on it slides into the slightly flattened eye-bolts on the lid. Fasten the bracket to the inside of the door 9⅛ inches from the right outer edge (inside view) and even with the top of the door. Locate the eyes 9⅛ inches from the left edge of the top and ½ and 1¼ inches from the front edge.

Bolt the handle to the center of the top and reinforce with washers on the under side. Give the case two or three coats of clear varnish, wax and polish. You now have a very useful carrying case for service calls. The substitution tester in the lower left compartment is (to the author) one of the most important features of the equipment. However, every service technician has his own pet "substitutionalyzer" or other personal test instrument. Put it in that compartment to complete your equipment!

Bill of Materials

Quarter-inch plywood

(Dimensions in inches)

2—20½ x 19, front and back
1—20½ x 10, top
2—19 x 1½ for door sides
2—19 x 8, left and right ends
2—17½ x ½, book compartment fronts
2—1½ x ½, tool rack holders
1—20 x 1½, door bottom
1—20 x 8, bottom
2—20 x 2⅞, front and back of drawer
1—20 x 7¾, shelf
1—20 x 1, tool rack
1—14 x 8, sig. gen. compartment bottom
1—6 x 8, v-o-m compartment bottom
1—17½ x 1½, book rack bottom
1—2¼ x 1½, soldering iron compartment bottom
1—19¾ x 7¼, drawer bottom
7—2⅝ x 7¼, drawer sides and divisions
1—½ x 6, v-o-m compartment lower facing strip
2—½ x 2¼, soldering iron compartment fronts
1—10 x 8, partition between v-o-m and sig. gen. compartments
1—8 x 6, v-o-m compartment back
1—7 x 6, substitution tester panel
3—5¼ x 7, divisions of shelf
1—2 x 7, sig. tracer compartment side
1—7 x 2¼, sig. tracer compartment bottom
1—13 x 1½, partition between soldering iron compartment and book rack
2—9½ x ½, sig. gen. compartment side facings
1—14 x ½, sig. gen. compartment bottom facing strip
2—9½ x ½, sig. gen. compartment side facings

Hardware and miscellaneous

6—1½" x 1½" butt hinges; 3—hasps (about 1" wide by 3½" long; 30—½" x 6⁄32" bolts with nuts; 1—handle for top; 24—⅜" x 5 flat-head wood screws; 3—metal washers ¾" diameter; 6—metal washers, ⅝" in diameter; 3—right-angle screw hooks ¾" longest way; 2—¾" over-all eye bolts with a ⅜"-in-diameter eye; 1—service decal; ½ pt.—clear varnish; small box ¾-inch No. 17 flat-head wire nails; ¼ pt.—good quality liquid glue.

—end—

New Life for Old Radios

By JACK DARR

The author at his bench, working over one of the old-timers.

ALMOST every family has a couple of older sets somewhere. These old jobs may not look very pretty, and they may not play very well when you get 'em, but with a little patience and some careful service work, they'll furnish lots of good entertainment. Many of them are surprisingly well constructed, and you'll be astonished at the circuits you'll find in them. (The first push-button tuner the writer ever saw was on a Fada, back in 1928, and it was about three years old then!) Lots of them used triodes in a push-pull audio stage, with a generous-sized speaker, and the tone quality excels most present-day models.

The tubes used in these sets are often easier to obtain in shortage periods than the miniature and octal-loctal tubes used in the later models. In fact, you've probably got several full sets of good tubes in your junk-box right now. I have. All you need is a little brushing-up on some of the circuits common to the older models which aren't encountered in the 1940-1951 sets.

Power supplies

Most of the 1929-1939 sets used a straight transformer power supply, with an 80 rectifier. Any of the 5-volt full-wave rectifiers may be substituted for it, if there is any reason to do so, by changing to an octal socket, and wiring to fit the tube available. Types 5Y3, 5Z3, 5R4, 5U4, and several others will work.

If the set was built before 1935, the chances are that the original filters were wet electrolytics, from 8 µf up, at 450 volts, or less; 4- and 2-µf filters were found in many of them, and some had paper units. These will have long since gone the way of all flesh, and the replacements themselves probably won't be too good. Check them carefully, and replace with new dry electrolytics, from 8 µf on up, at 450 working volts.

Watch out for the hot-negative circuits on quite a lot of these. The filter chokes, speaker fields, and bleeder resistors were occasionally connected in the negative return lead, and the resultant voltage drop was used for the high bias voltage required on the triode power stage. You can't use a common-negative filter on these, and the common-positive units are sometimes hard to locate. Use single tubular units, and you can connect them in any way necessary. See Fig. 1.

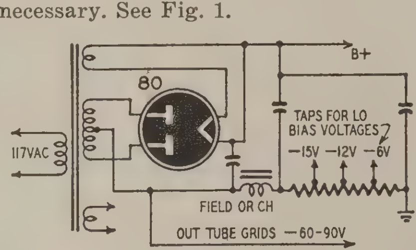


Fig. 1—A common old-time bias system.

A number of the older designs used a filter choke, or the speaker field, or both. Check these for opens and grounds. If a speaker field shows an open circuit, check the outer layer of wire. Often the trouble occurs here, where the lead wires are connected to the fine wire of the winding. If it's not repairable, use a separate filter choke. You'll usually find room to mount this on the chassis. Then use a PM speaker.

Bleeder resistors will be found across the power supply, to improve regulation, and to provide taps for the various screen and plate voltages. See Fig. 2. These were either *Candohms* or wire-wound ceramic units. If one section is open, the rest of the voltages will be upset and some stages deprived of all voltage. Replace the open section with a 10-watt resistor of the correct size, fastened across the terminals of the old resistor. If this is a Candohm, run the tip of a knife-blade through the old resistor or remove it, to insure that it will not heal up and upset the voltages. When repairs are finished, tap the whole resistor briskly, to locate any more possible open sections.

Audio stages

These radios used triode class A audio stages regularly. The tubes used, 45's, 2A3's, etc., require a bias voltag that seems astonishingly high to u now, accustomed as we are to the 10–1 volts required on pentodes. The 45's for instance, require at least 60 volts o negative bias, with a plate voltag around 300. If bias voltage is low, plat current will run much too high, causin low plate voltage, loss of volume, an possible overheating of power trans formers and other components. You wi find numerous cases where previous re pair jobs have resulted in imprope connections in the bias supply. This ca result in loss of bias, distortion, an other troubles. Check bias resistor input transformer secondary windings and bleeder resistors, for continuity an proper resistance.

You'll find resistors and capacitor mounted on terminal boards and strips This makes servicing easy, but there i always a possibility of leakage throug the insulating material of the termina board itself. We found one set wit heavy leakage from the high-voltag terminal to the first audio grid, result ing in a severe loss of volume.

Watch for leaky or intermitten capacitors, especially in audio couplin circuits and screen or plate bypasse Even micas aren't immune, if they'r old enough. Check grid and plate-loa resistors for correct values, replacin those which have shifted too much.

Lots of these old-timers used "block bypass capacitors with as high as seve or eight bypasses in a single can. Re turns often changed inside the can, to making them difficult to trace. If yo

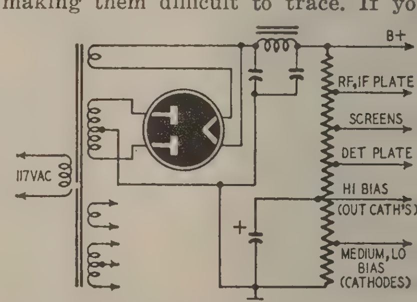


Fig. 2—Bleeder resistors were commo

find one defective, cut the lead close to the can, and install a separate unit at the tube socket. It's not a bad idea to check the rest of the capacitors in the can, too.

The size of capacitors used in these sets varies somewhat from modern practice. Screen bypasses ran up to 0.1 μf, and the B-plus or plate-return bypasses were 0.25 μf, or even 0.5–1.0 μf. Bypasses in a.v.c. circuits were in the vicinity of .02–.05 μf, and the a.v.c. filter resistors were 0.1–1.0 megohms. Cathode bypasses when used, were from 0.25 to 0.5 μf.

Coupling capacitors ran from .02 to 0.1 μf. Check these carefully for leakage and capacitance. Most sets used input transformers for the power stage, and the coupling capacitors were found only in the driver or first audio input.

Output and input transformers were about the same then as now, with the exception of their physical size. Modern units will be less than half the size of the original units. Plate-load impedance of the triodes is rather low, so the d.c. resistance of the windings will be correspondingly less. Watch out mostly for balance between the two halves.

Input transformers will be found with open primaries, mostly. Secondaries are rarely found opened, but they deserve a check, especially if the set has not been used for a few years. If the secondary is good, but the primary open, with no replacement available, try shunting the primary with a resistance equal to the plate-load resistance of the tube, and coupling the signal into one of the output grids with a capacitor, about .05 μf. Leave the secondary connected as it is. This is a fairly good emergency repair. If you want to play with it, remove the transformer, and make a simple phase inverter out of the driver tube. This depends mostly on how much time and money you want to spend on the set.

R.f., i.f. and oscillator stages

Intermediate frequencies in these sets ranged from 175 kc and even lower about 1929-1932, some 370 kc, some 265 kc, and some in the 450-kc band used so widely now. The correct i.f. can be easily identified with a signal tracer, by connecting the i.f. probe to the detector, and tuning in some noise. Maximum response will be found in the vicinity of the proper i.f., no matter how badly the set is mistuned. For instance, if you get the highest reading around 200 kc, it's very likely a 175 kc i.f.

Watch out for electrolysis damage to r.f. and i.f. primaries, and oscillator plate windings. Any winding carrying high-voltage d.c. is liable to this trouble. In the older radios, breakdowns due to this cause are frequent. You can check all coils for continuity, or wait until you start aligning. Trouble of this type will show up instantly, by severe flattening of the response, or the complete absence of a peak while tuning.

If the set displays over-all weakness, with good tubes, it very likely needs aligning. Look up the correct i.f. and the location of trimmers in service manuals. If you don't have a schematic for this particular set, sometimes the i.f. can be found by measuring the resistance of the i.f. transformers, although this is a rather rough way. Old service data is pretty complete, and you can find the i.f.'s of many of these sets listed in manuals of the period.

If you are in the habit of using a signal tracer for aligning, connecting the i.f. probe to the diode plate, you may encounter trouble in the older sets, which sometimes used triode "power detectors," etc. If you get erratic indications or oscillations, especially in the older auto radios, go back to the output meter across the voice coil.

Check up on antenna coils. Lots of these were shielded, in large cans, and damage may go unnoticed. If the line bypass capacitors, from the a.c. line to chassis, have shorted out, the antenna coil primary will burn up if the antenna post is grounded. This will lower the sensitivity quite a bit, even if the coil does not open up. They may be replaced by the separate primary coils, or the whole unit changed to a modern type iron-core coil.

When testing the oscillator section, be sure that the oscillator is delivering sufficient voltage over the entire band.

The most common pentagrid converters used in these sets (often 6A7's or 6A8's) should develop at least 15 volts d.c. at the low-frequency end of the band. With the sets using a separate triode oscillator, such as a 76 or 37, the readings will be about the same. Watch for shifting of the grid and plate-load resistors, also the cathode-bias resistor used in some circuits. Mica capacitors used in grid circuits will develop intermittent connections.

Mica insulation in trimmer capacitors on the older sets sometimes causes trouble by moisture absorption or physical damage. Oscillator drift and intermittent operation may sometimes be traced to this. While we're on the subject, look out for the little gimmicks used in lots of these sets—two pieces of wire, connected to the oscillator and r.f. sections of the tuning gang, and twisted together to make a small capacitor. If these are made of braid-covered wire, dampness will sometimes cause a leakage and a very puzzling intermittent.

Tuning capacitors used in the old sets are quite a bit larger than modern units. Check carefully for bent or damaged plates, also for proper grounding. Noise while tuning is often caused by loose grounds. Clean and check the grounding springs, and install pigtail grounds of flexible wire if necessary. You can get most of the dust out with an air-hose, or with the high-voltage test of your capacitor tester. Disconnect the lead wires from the gang, and connect the high voltage across one section at a time. Rotate the plates until sparking ceases.

Volume controls

Several unusual volume-control circuits were found in the older sets. Volume control in the screen-grid circuit (Fig. 3-a), in the r.f. cathode, and in the antenna, or a combination of the last two (Fig. 3-b) were common. Any of these may be changed to our more usual audio-grid circuit, if the original control is defective. However, many of these sets lack a.v.c. Relocating their volume controls will cause the r.f. stages to overload and distort on strong signals.

With the screen or cathode type of control, install a resistor in place of the control, of the proper size to give maximum gain. This is easiest found by experimenting, or cut-and-try. Then install an audio-grid control in an appropriate place. The antenna control may simply be removed and a new control installed, as most of these were low-resistance pots, shunted across the antenna coil primary. Where irreplaceable dual volume controls were used, a potentiometer may be used in place of one of them and a fixed resistor substituted for the other. If additional control is required, it can be put in the audio end. Watch out for single controls used as combination antenna shunt-r.f. bias controls; the slider was grounded in this type, and the antenna connected to one end, the cathode to the others, as in Fig. 3-b.

General hints

These sets are old! They've been stored for some time, and have probably accumulated quite a cargo of dust and dirt, and perhaps visited by several families of mice. Apply a vacuum cleaner or a brush to the set and clean it up as much as possible. This will make the service job a great deal easier, and neater.

Watch out for mouse damage to wiring, transformers, coils, speaker cones, etc. Mickey Mouse loves to gnaw on wires, and he may have cleared himself a space to build a little home right in the middle of the chassis.

Tune it up carefully, give the cabinet a good going-over with polish, and you'll probably have a set that will surprise both you and the customer. It'll make him very happy. And don't forget, if he's happy, your steaks will be quite a bit thicker than they will if he isn't!

—end—

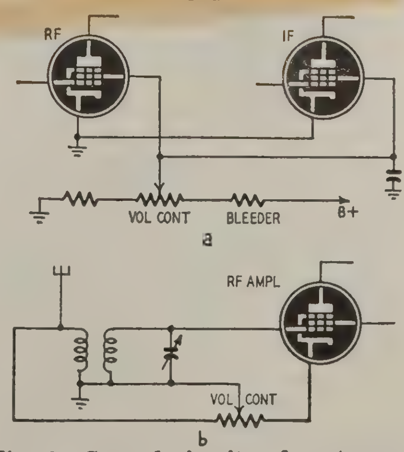
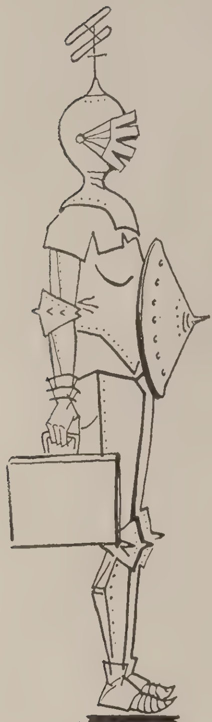
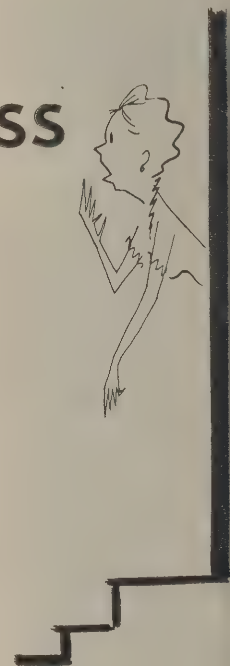


Fig. 3—Control circuits of yesteryear.



Formula for TV Success



By JOHN D. BURKE

Video receiver service demands new techniques but the old fundamentals of good business and common sense are needed more than ever before

MY experience is similar to that of thousands of men who are keeping the world's TV's going. We were radio repairmen. TV was thrust upon us.

Others are leaping directly into TV. Their road has been harder. They bit off more than they could chew. Some have gone bankrupt. Others are on the way now.

Once upon a time radio sets had only a 90-day warranty. This was the responsibility of the dealer, with the factory replacing parts or tubes. But—TV is a very different story. Much more complicated than radio sets; containing expensive components; involving special type aerials and lead-ins; requiring sometimes two men on service calls; involving complex customer instruction problems; and all this for *one year!*

TV contracts have satisfied neither the customers nor the contractors.

This is not for me

TV sales are not for me—for a number of reasons. The main one is subjective. I do not like the relationship of merchant to customer. Such relationships all too often lead to mistrust. Even when the merchant is actually giving away his merchandise at a small profit—or even a loss!

Antenna installation and repair requires special equipment, courage, and agility. One of my friends gets all my aerial work. He makes some nice money.

He can have it. He would prefer to be able to repair TV receivers and stay on the ground. He's still up in the air!

I used to heartily endorse three makes of sets. "This one is best; this second best; and that one third." In line with these endorsements I took people to a very nice dealer who sold a few sets on my suggestion. For about a year I continued this practice.

The result? I lost the friendship of those who took my suggestions. With over 80 manufacturers building TV's, is there not room for terrific conflict in every family, and groups of friends, as to which is best? More fools we to express any opinion!

I also had a strained relation for a time with my dealer friend. One of my prospects showed interest in an $800 model. The dealer ordered it. The customer changed his mind.

When asked, I *now* tell people the names of those makes which I think are *no good.* So far, this advice has not boomeranged. Otherwise, "Take your choice!" say I.

In confessing one of the reasons for my hesitation over plunging into TV work, a couple of years back, perhaps I will help you also.

Frankly, I was scared of the picture tubes. They could explode! (Implode, they say. Same result.) They involve very high voltages. (I've been nipped a few times.) They cost too much

Many a time I've broken out into a cold sweat while, as gently as possible, I tugged and pulled and twisted and turned, trying to ease the neck of a big hunk of tube out of a tight yoke.

Brother—if you have had that experience—you know what I mean. Where else would the tube be, while this goes on, except smack up against your chest?

"Wear goggles and gloves," they say. Give me a suit of armor!

That fear is not as great now—but I shall always handle those babies with the respect they deserve.

After a while you learn to discharge the tube itself, as well as other capacitors, before getting near them. But—who let those engineers loose who put metal picture tubes in certain sets, and then put a knob for setting up the stations right alongside that killer—a knob we are supposed to reach like contortionists from the back of the set.

Ah, well! At least the high voltage on most sets carries little power nowadays, since the introduction of flyback transformers.

As you may have surmised, mine is a one-man shop. My approach is to regard myself as similar to a doctor. Some of my patients come to the office. Where possible I treat them in their home. No use to make a hospital case out of each headache.

This *does not mean* taking tubes out and replacing them, one by one, blindly. It does mean taking along on every call not only a complete set of tubes, but the *diagram* of the set, soldering iron, a few capacitors and resistors, a meter, tube

substitution book (very necessary nowadays). In each case I try to get the model number at the time of the first phone call. Most people have no idea what it is—they have to hunt for it while you hold the phone.

So, you arrive. Since it is to your interest to do the job fast, you come prepared. You do not forget your "cheater cord." Tubes account for the greatest percentage of TV troubles. The defective one usually can be determined quickly. Many other jobs can be done at home, including capacitor and resistor replacements.

There is a psychological point, however, where it is best to call a halt and propose taking the set to your shop.

To my shop come three types of jobs: Those I bring in; those brought me by other repairmen; those people bring in.

Tough repair jobs have included: one or more bad capacitors; open sweep transformers; bad selenium rectifiers; wrong-value resistors; bad switch contacts; poorly soldered connections; a few burned-out transformers.

"Hey, there!" you cry, "what about alignment?"

What about it? Leave those screws alone, say I. It is a rare case where I have to do any alignment. Do I use a sweep generator, then? No. Sorry. I have no sweep generator. I use the test pattern. My oscilloscope tells me the cause of poor synchronization.

Here's a couple of examples of my rough-and-ready method: A Du Mont, with picture and sound separated too far so that on weak stations you could only get one or the other. I simply adjusted sound i.f. down to meet the picture. Simple. Another case: the set used several 6J6's. All channels were off frequency indicating a changed oscillator tube characteristic. Simply switched 6J6's in the customer's home. Everybody happy.

Keep the bills down

Long before the tube situation got tight I had a policy of changing very few tubes. You make more money, and charge the customer less. If a tube is working, why replace it? If your charges are moderate, they will call you back again.

Try to demonstrate that TV sets can be kept operating on a job-to-job basis at *less* than they would pay for contracts—and with better service. Far better—three or four calls per year—totalling *less* than a year's contract.

Results of these policies? No arguments on the phone. Everyone is friendly. Recommendations spread your fame. In time, you will have to limit your customer list—or expand.

But then other troubles will start. I leave that to those who want to get rich. Just give me enough work to make a good living, and enough leisure to live a good life. —end—

Improved Audio For The 630

By CHARLES B. REMER

RECENTLY I purchased a television chassis, one of the popular 630 type. It came equipped with a Du Mont Inputuner, as I had planned to use the set for FM as well as television. It also had a 12-inch speaker.

The audio fell far short of desirable FM quality, but I decided that by making a few changes, adding treble and bass boost, it could be improved.

First it was determined that there was not enough gain to work with. The answer was to replace the 1st audio tube, 6AT6, with a pentode. A number of miniature tubes could be used, but since 6AG5's were on hanl they were selected. Other tubes such as 6AU6, 6BH6, 6AK5 would be satisfactory.

A boosting network designed to give a moderate amount of treble and bass boost was inserted between the 6AL5 detector load and volume control.

This network was tried before the feedback was used, and although it worked well it still lacked enough bass. More boost could not be used because of the gain limitations. There was also some high-frequency distortion.

Feedback between the cathode of the 6AG5 and output transformer was then tried. The amount of feedback was adjusted to the gain available by a voltage divider across the secondary.

The amplifier was very stable and more feedback could have been used had there been more gain.

Rewiring the audio

The actual changeover is easy. First, remove grid capacitor C3 and grid leak R4 from pin 1 of 1st audio tube socket (6AT6) and rewire pin 1 to center of volume control. Coupling capacitor C3 can be used between the 6AL5 output lead and the network. Mount on unused terminal above the 6AL5 shield.

Coupling capacitor C5 is rewired from pin 7 to pin 5, and plate bypass C4 is removed.

A new plate-load resistor R11 and 6K6 grid resistor R12 are wired in. Don't disconnect R6 from terminal strip over the 6AL5 shield. It can be used for part of the bias voltage divider for the 6AG5. Rewire grid end of R6 to bottom of volume control with R9.

The cathode lead may be pushed through a hole that is already in the chassis next to pin 7 and run to voice-coil terminal strip directly above hole. The two resistors making up the feedback voltage divider can be mounted on this terminal strip.

Keep cathode lead as short as possible. Don't forget to disconnect ground from pin 2. The 6AG5 screen resistor R10 and capacitor C8 can now be wired, and network resistors R7 and R8 with capacitors C1 and C7 can now be put in between volume control and 6AL5 to complete the conversion.

If after all wiring is finished the set should oscillate when turned on, reverse voice-coil leads on output transformer.

By using both feedback and the treble-bass boost network the audio now sounds good and the time and effort put into the conversion has paid off.

(It appears that Mr. Remer may have had conditions, either due to his speaker, cabinet, room, or some other factor or combination of factors, that cut his treble exorbitantly. He has removed C4—which formed part of the original 630 treble de-emphasis circuit—and has added treble boost with C7. His reception should be screechy indeed. If other readers, using other components, find this to be the case, they may find it advisable to again cut the treble, by omitting C7 or by putting another (but smaller) capacitor between ground and R1–C3 junction.—*Editor*)

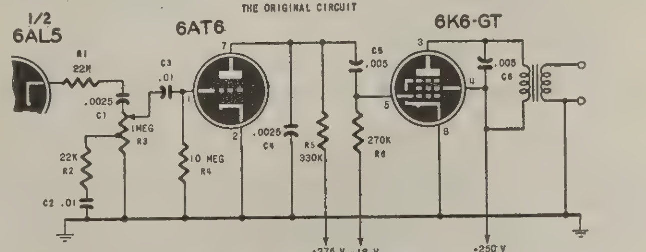
Parts List

Resistors: (Original parts) R1, R2—22,000 ohms; R3—1 megohm, variable (volume control); R4—10 megohms; R5—330,000 ohms; R6—270,000 ohms. (New parts) R7, R10, R12—1 megohm; R8—70,000 ohms; R9—47,000 ohms; R11—500,000 ohms; R13—100 ohms; R14—5,000 omhs.

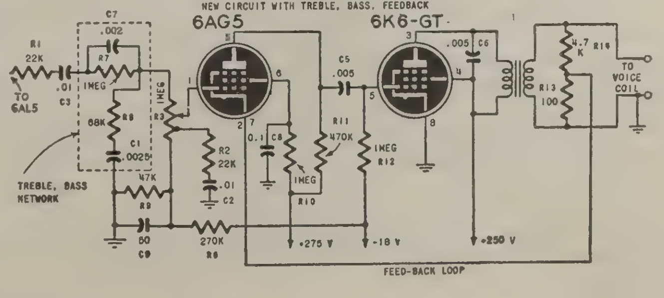
Capacitors: (Original parts) C1, C4—.0025 µf; C2, C3—.01 µf; C5, C6—.005 µf. (New Parts) C7—200 µµf; C8—0.1 µf; C9—50 µf, 25 volts electrolytic
New resistors may have ½ watt rating; capacitors are paper, 400 or (better), 600 working volts except where noted.

—end—

THE ORIGINAL CIRCUIT



NEW CIRCUIT WITH TREBLE, BASS, FEEDBACK



Television Service Clinic

Conducted by MATTHEW MANDL

A LARGE number of the queries received by the Television Clinic relate to problems which arise after converting to large-screen receivers. (As with most of the letters which are sent to the Clinic, the answers are sent directly to the readers and only those of greatest general interest are published each month.)

One particular trouble which occurs after conversion merits discussion here because it occurs often with many types of receivers. That is the horizontal (and sometimes vertical) instability which occurs after rewiring the high-voltage system for the bigger tube.

Theoretically the sweep stability of the receiver should not be affected, because during conversion no changes are made in either the vertical or horizontal oscillator. What does happen, however, is that the increase in sweep necessary for the larger picture tubes will usually increase the voltage supplied by the voltage-boost system.

With many receivers the voltage-boost output is used to furnish B-potentials for either the horizontal oscillator tube or the discharge tube. In some receivers both such tubes receive their voltage from the boost system and sometimes the vertical circuits also are supplied with plate voltages from this source. A typical voltage-boost circuit of this type is shown in Fig. 1.

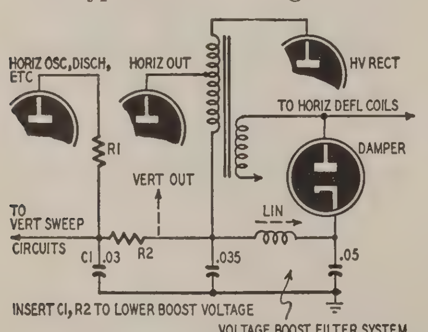


Fig. 1—Commonly used booster circuit.

When the high voltage and sweep output are increased during conversion, the transient-pulse amplitude increases and the damper tube rectifies a higher voltage and passes greater current. The output of the voltage-boost system will therefore increase. This increase is usually welcome to the horizontal output tube because it aids in getting more sweep amplification. However, when this increase in boost voltage is applied also to vertical and horizontal oscillator plate circuits it can upset circuit specifications sufficiently to cause instability.

Attempts to re-establish stability by adjusting hold controls are usually of no avail, and upsetting the frequency or phase control settings of the horizontal lock system will only entail complete realignment after the plate voltages have been brought back to normal.

The method for reducing the boost voltage to the sweep oscillators while retaining the increased amplitude for the horizontal output tube is shown in Fig. 1, where R2 and C1 have been inserted. The series resistor R2 should be chosen by trial and error while taking a voltage reading at the plate of one of the circuits fed by the boost system. Check for proper voltage with the manufacturer's schematic and change the value of R2 until values are correct.

To prevent R2 from acting as part of the load resistor (R1) of *any* of the circuits which are fed by the boost, a capacitor (C1) is inserted to ground as shown. If the final value of R2 is too low, linearity may be upset slightly and will have to be adjusted a little.

In receivers where the vertical output stage voltage is also secured from the voltage-boost system the circuit should be so arranged that full boost is applied to vertical output. This can be done by making sure the feed line to the vertical output is taken off *prior* to the newly installed dropping resistor as shown by the dotted line in Fig. 1. This will aid in getting increased height for the larger picture tube.

Sweep instability

A Garod 920 receiver develops severe vertical and horizontal instability after operating about an hour. Changing tubes in both sweep circuits did not help. E. S. R., Morgantown, W. Va.

Both horizontal and vertical sync loss indicates trouble in the sync separator system preceding both vertical and horizontal circuits. There may also be a defective tube in *any* stage prior to sync take-off, from the tuner through picture stages. Check these tubes by direct substitution, for often a tube will change characteristics slightly and clip sync levels while still giving a good picture in terms of general quality. Such tubes often check O.K. in an ordinary emission type of tester. If tube substitution does not clear the trouble, check for a faulty part in the separator.

Vertical foldover

In a Hallicrafter T-54 there is pronounced foldover at the bottom of the picture. This is accompanied by poor vertical linearity. G. P. O., Richmond, Va.

A leaky coupling capacitor between the vertical oscillator and the output tube is the usual cause for poor vertical linearity accompanied by foldover. The degree by which this condition can upset linearity and cause foldover is shown in Fig. 2, The pattern on this receiver was perfectly formed prior to a defect

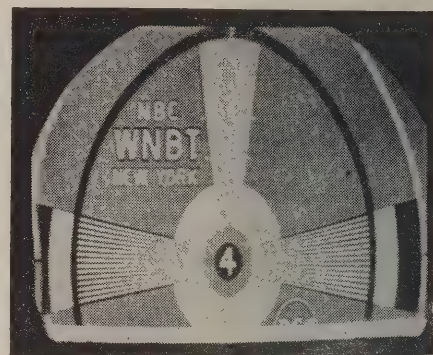


Fig. 2—What a leaky capacitor can do.

developing in the coupling capacitor feeding the vertical output tube. When the coupling capacitor which caused this condition was checked, it was found to have a leakage resistance of 400,000 ohms.

Replace defective coupling capacitors with the same type and capacitance rating. Defective tubes and other capacitors also can cause such troubles and should be checked throughout the entire vertical circuits if the trouble persists.

Horizontal smear

I am experiencing difficulty locating the cause for horizontal smearing of objects in the picture. The appearance somewhat resembles that of ghost reception, except that poor definition is also present. The picture really appears out of focus. E. R. W., Washington, D. C.

Horizontal smear, or "trailing smear" as it is sometimes called, is caused by poor low-frequency response in any picture section of the receiver (usually in the video-amplifier stages). The most common cause for this is a defective capacitor in the decoupler circuit. The latter is the resistor-capacitor combination between the B-plus supply and the load impedance of a tube. It isolates stages from interaction between each other and also boosts low-frequency response. Check all tubes and parts (particularly decoupling and coupling capacitors) from video detector to video amplifier inclusive.

Finally the picture i.f. stages should be checked, because any abrupt change in tube characteristics or in component

parts which might affect low-frequency picture sideband response will produce similar symptoms.

Hum bar in slave unit

What would cause 60-cycle hum bars in a slave unit but not in the master receiver? The remote unit consists of video, audio, and sync amplifiers, sync circuits, power supply and picture-tube circuits. R. P., Fort Madison, Iowa.

The dark and light hum-bar interference is caused by 60-cycle ripple voltage entering the video amplifier and sync circuits of the remote unit. This is usually caused by a defective tube which has a cathode-to-filament short, though occasionally a poorly filtered low-voltage power supply will cause this trouble. If the latter is at fault, however, hum will be heard also from the speaker. The fact that the hum bars are not present in the master unit localizes the trouble to the slave unit. Check tubes by direct substitution.

Picture shrinkage

On a Craftsmen RC-200 the picture shrinks in from the side about one-half inch after the first 10 minutes of operation. Replacing the horizontal output tube did not help. When the trouble first appeared the picture shrank in all around equally, but I was able to remedy this with vertical linearity and vertical size controls. What can now be done for the horizontal shrinkage? M. L., Amboy, Ind.

Normally you should expect a slight change in picture size in any receiver after the first five or ten minute warm-up period. Until the high-voltage system reaches correct amplitude, slight blooming occurs, and then the picture assumes the proportions it will keep while the set is in operation. It is only if the picture size reduces beyond the point where the width or height controls can give full masking that other troubles might be indicated.

You stated that you cured vertical shrinkage by adjustment of vertical controls, yet these two controls would not affect intermittent vertical size unless the controls are defective. If, as in your case, size changes only during warmup, it is more likely that you increased the vertical size beyond the picture mask and thus did not notice the slight shrinkage during warmup. The same can be done with the horizontal, by adjusting horizontal width until the picture is properly masked *after* warm-up.

Wait until a station pattern is on the air and readjust all controls after the set has reached proper temperature, and with the contrast set for normal viewing.

Poor picture in remote unit

After installing a 10HP4 in parallel with the 7JP4 in an Admiral 19A1, I get a very weak picture on the remote tube (located 50 feet from the master unit). When brightness or contrast is advanced, the picture turns negative on the 10HP4 but the 7JP4 operates normally. How can I correct this trouble? S. S., Philadelphia, Pa.

The 50-foot run to the remote is excessive for good reception and will introduce considerable loss. The negative picture results because the long connecting cable introduces too much stray capacitance and cuts down on the high-frequency components of the picture signal by acting as a low-reactance shunt.

With just the lower frequency picture signal components left, an advance of controls will result in a negative picture because sync, blanking, etc., are all out of proportion to the higher frequency signal amplitudes. Paralleling tubes is not good practice even with ones having similar characteristics such as the 7JP4 and 10HP4. A much better arrangement is to employ a slave unit as described in RADIO-ELECTRONICS in the August, 1951 issue.

Projection changes

What changes are required for substituting a 3NP4 projection tube for a TP400 in a Philco model 48-2500? C. H. B., New Orleans, La.

Such a change would have to include new deflection and high-voltage systems as well as changes in the optical system because of the difference between these two tubes. The 3NP4 has a 2.5-inch face, a 5-prong base, and uses 25,000 volts in the high-voltage system. The TP400 has a 4-inch face, requires 20,000 volts for the 2nd anode and uses a different type of deflection yoke.

The best way to change the receiver over is to use a complete "package" unit such as the *Protelgram* put out by the North American Philips Co. This unit comes complete with a yoke, corrector lens, mirror, and other components in a small housing. Another compact unit contains a separate power supply. The old unit and optical system would have to be removed and replaced with the new. It could be mounted in the cabinet at an angle to throw the picture on the present Philco tilted screen if it should be desired.

—end—

TV PREDICTIONS

Though sporadic ionization in the E-layer region of the ionosphere may bring about dx propagation of low-band TV signals occasionally at any season of the year, there are two periods when such dx is much more frequent than at other times. These are spread either side of the shortest and longest days of the year. The winter season is the shorter of the two, but the TV dx enthusiast will find it well worth while to keep a close watch on the lower channels from about the middle of December through the first week of January.

In the northern half of the country, where December means winter, in fact as well as in name, the reliable reception range for all channels will average considerably less than for the previous eight months. This will mean generally poor fringe-area reception, but in locations where co-channel or adjacent-channel interference was a problem in the warmer months the lessened tropospheric bending may bring about some improvement in reception.

Tropospheric bending can be pronounced in December, too, but the *average* signal strengths observed for the next few months will be considerably below those of the April-November period. Times when tropospheric conditions will be good can be predicted readily at this season by no more than observation of local weather and a daily look at the weather map. "Increasing cloudiness and warmer" is the weather prediction that means tropospheric dx in the winter months, particularly after a slow-moving high-pressure center has passed or is in the process of passing.

Aurora borealis is less likely to occur in December than in the other cold months, though the northernmost portions of the country will probably experience a few disturbances of sufficient severity to affect at least the lower TV channels. Very few aurora observations have been received to date, and TV dx-ers are asked to turn their arrays to the north and check reception carefully whenever an aurora is seen. Most likely to result in observable effects on TV reception are the displays in which well-defined vertical rays or curtains are seen

—end—

Some important lessons for radiomen are carried by this

Light Sensitive . . . ELECTRONIC BEAST

By EDMUND C. BERKELEY

ON the cover of this issue of RADIO-ELECTRONICS is a picture of a small robot which has four sensing organs, three acting organs, and a small electronic and relay brain. His name is Squee, the Robot Squirrel. What he does is roll along the floor, hunt for "nuts," pick up a "nut" in his scoop, take it over to his "nest," leave it there, and then hunt for more nuts.

Although Squee is not a very clever robot, he does have a small amount of memory and of reasoning ability, and he is a close cousin of his predecessor, Simon, the Midget Electric Brain. Simon was the main subject of a series of thirteen articles in RADIO-ELECTRONICS from October, 1950, to October, 1951, by Robert A. Jensen and this author.

There are a number of interesting things about Squee, himself, but the most important of them is that he is in many ways a good illustration of a powerful new method for the design of circuits for mechanical brains and robots. This method is the *algebra of logic,* also called *Boolean algebra.* The engineers at Northrop Aircraft Co. in California, who designed the electric brain Maddida, say they have given up drawing circuit diagrams in many places because Boolean algebra does a better job.

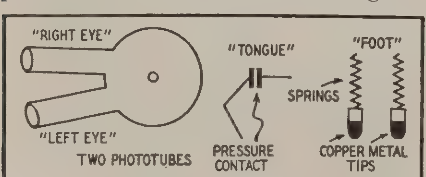


Fig. 1—The electronic sensory organs of Squee.

In this series of two articles the main emphasis will be on Boolean algebra: what it is, how you can calculate with it, and how it can be used in practice. The secondary emphasis will be on Squee. But first a few more words about Squee.

Why did Edmund C. Berkeley and Associates build Squee? Well, last year Bob Jensen and I read some articles about a mechanical tortoise made in Bristol, England, by Dr. W. Grey Walter at the Burden Neurological Institute. We said to ourselves, "Let's make a robot like that—but have him do something a little more clever." So we came up with the idea of a squirrel gathering nuts, and decided to make a robot squirrel.

Squee was constructed mainly through the efforts of three men—Robert A. Jensen (until he re-entered the Air Force in June, 1951), William Szabo, and Jack Koff. Bob Jensen made the skeleton, a framework holding a front wheel for driving, a pivoted column

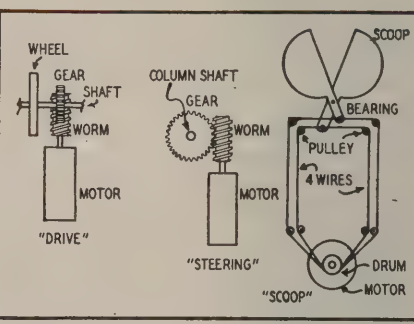


Fig. 2—These are the squirrel's motor organs.

holding and steering the wheel, and two rear wheels rolling free. He mounted tubes, relays, and batteries. By October, 1950, the machine was responsive to light (but only to one kind of light). It still had no "hands." In March, 1951, we made a commitment to exhibit Simon and Squee at the Minnesota State Fair, August 25 to September 3, under the auspices of The Dayton Co., a large department store of Minneapolis. The project that had started as fun became good business. We undertook in earnest the work of making the machine sensitive to a second kind of light, and to give it the needed hands. The scheme for the scoop and the nest light was the main contribution of Szabo, and the final completion, testing, and modi-

fication of the machine was due to Jack Koff. Squee was exhibited ten hours a day for ten days in Minneapolis, and probably 50,000 people saw him.

The design of Squee

The physical design of Squee is based on hitching together the sensing organs (see Fig. 1) and the acting organs (see Fig. 2) with appropriate hardware. The logical design of Squee is based on the Boolean algebra relating the conditions expressed by the sensing organs and the conditions expressed by the acting organs.

The first two sensing organs are the *right eye* and the *left eye*, the two photocells. They enable Squee to scan the surrounding environment; as Squee turns his steering column, the photocells look in one direction after another for nuts or nest. A nut (currently a golf ball) is lighted from above by a steady light, a d.c. light. The nest (currently a 12 x 18-inch sheet of aluminum) is lighted by a 60-cycle a.c. gas-filled lamp giving 120 flickers a second.

In Squee the physical circuit using electronic tubes connected to each photocell reports at any time three logical conditions. These are: darkness; a.c. light; and either d.c. light only or both a.c. and d.c. light. The possible logical reports from the circuit, for each phototube are:

Condition No.	*Darkness Report*	*A.C. Report*	*D.c. or d.c. and a.c. Report*
1	1	0	0
2	0	1	1
3	0	0	1

Here the 1 designates "yes" or "reported" or "on," and the 0 denotes "no" or "not reported" or "off." Notice particularly that this circuit, which we called the Amplifying Circuit, was unable to report "d.c. and not a.c."; there will be a lot to say about this point later.

The third sensing organ of Squee is a contact-reporting switch taken from a vending machine, and installed at the base of the scoop. We called this the "tongue." When the nut (ball) entered the scoop, it would roll against this contact switch and close a relay, thus telling Squee that it had taken hold of a nut.

The fourth sensing organ of Squee is a "foot," consisting of two copper tips mounted on springs, which trail along the floor. If and when both of them touch a metal plate (the "nest"), a relay is closed, and Squee "knows" that it has found the nest.

The possible logical reports from these two sensing organs are:

Tongue Report	*Foot Report*
1	1
0	0

We come now to the acting organs. After a lot of pondering over various ways of giving energy to the acting organs, and the problems of clutches, we finally decided on the simplest, though crudest method: We hitched a separate motor to each part that had to be moved, and we provided that it could be de-energized, run forward or backward.

For the drive wheel, we mounted a gear on the drive shaft, and turned that gear with a worm wheel mounted on the shaft of the drive motor. For steering, we mounted a gear on the column shaft, and turned the gear with a worm wheel mounted on the shaft of the steering motor. In the case of the scoop, we had a problem. There was room to put a motor at the bottom rear of the chassis. But the scoop was at the front of the chassis, even ahead of the column, and it had to be opened and closed like two cupped hands held together at the wrists. So we ran pulley lines made of light, flexible wire string, from the base of the scoop to the drum mounted on the shaft of the scoop motor; and we adjusted the amount of turning of the motor by means of limit switches, so that there would be two positions and the scoop would be either open or closed.

The possible logical reports about each of these three acting organs is:

Condition	*Motor On*	*Motor Forward*	*Motor Backward*
1	0	1 or 0	0 or 1
2	1	1	0
3	1	0	1

We have now reduced the sensing (or input) of Squee to a set of yes's and no's, or 1's and 0's. We have reduced the acting (or output) of Squee to a set of yes's and no's, or 1's and 0's. We now have left the problem of hitching the input and the output together, so as to express the desired behavior of Squee.

Ordinarily, up to this time, this kind of problem has been solved by the practical method of drawing circuits on paper, using prior rule-of-thumb experience with that method. But there

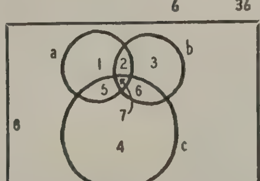
CHART 1—THE IDEAS OF BOOLEAN ALGEBRA

ELEMENTARY ALGEBRA	BOOLEAN ALGEBRA
QUESTION	
1. What symbols are used to stand for any things being talked about?	
a, b, c, . . ., x, y, . . .	a, b, c, . . ., x, y, . . .
2. What can the things be that are talked about?	
Numbers, like: 4, 8.57, —3, ⅛, $\sqrt{2}$, 3.14159. . ., . . .	(A) Classes, like: "Horses, Animals, Cows, Mammals, . . ." (B) The truth values (i.e., yes, no; or 1, 0) of statements such as: "Motor A is off." "Motor B is on." "Photocell C registers light."
3. What operations are there?	
PLUS: $a + b$ MINUS: $a - b$ TIMES: $a \times b$, ab DIVIDED BY: $a \div b$, a/b ROOT: $\sqrt{a}$, etc.	OR: $a \vee b$ AND: $a \cdot b$, ab NOT: a', $\backsim a$ EXCEPT: $a \cdot b'$ OR ELSE: $a \wedge b$
4. What special constants are there?	
ZERO, 0, such that $a + 0 = a$ for every a (and $a \cdot 0 = 0$, $a \neq \infty$) ONE, 1, such that $a \cdot 1 = a$ for every a, $a \neq 0$ INFINITY, ∞, such that $a + \infty = \infty$ for every a (and $a \cdot \infty = \infty$ for $a \neq 0$)	NULL CLASS, 0, such that $a \vee 0 = a$ for every a (and $a \cdot 0 = 0$) UNIVERSE CLASS, 1, such that $a \vee 1 = 1$ for every a (and $a \cdot 1 = a$)
5. How many are all the things that are talked about?	
INFINITY, ∞	2, or 4, or 8, or 16, or . . ., or ∞
6. What is an example of a rule?	
"The reciprocal of the reciprocal of a number is the number itself." $1/(1/a) = a$	"The truth value of the denial of the denial of a statement is the truth value of the statement itself." $(a')' = a$
7. How do you represent graphically the things talked about?	
(A) By points on an infinite line: See drawing on page 48 (B) By tables of numbers: (see below)	(A) By areas in a finite rectangle: (See drawing below) The areas No. 1 to 8 are: No. 1: $ab'c'$ " 2: abc' " 3: $a'bc'$ " 4: $a'b'c$ " 5: $ab'c$ " 6: $a'bc$ " 7: abc " 8: $a'b'c'$ The null class has no location. (B) By tables of truth values: (see below)

See drawing on page 48

(B) By tables of numbers:

a	b
0	0
1	1
2	4
3	9
4	16
5	25
6	36



(B) By tables of truth values:

a	b	c	d
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

is beginning to be a change: Designers have begun to use the methods of Boolean algebra to effect the logical design of circuits to express behavior. For connecting the input and output yes's and no's, 1's and 0's, is a problem in Boolean algebra. What is Boolean algebra?

Boolean Algebra

Boolean algebra is a kind of algebra named after a great English mathematician, George Boole, who lived 1815 to 1864. He wrote a famous book called *The Laws of Thought,* in which he laid out quite completely the design of a new algebra. It was somewhat like ordinary algebra but was adapted to the ideas and operations of logic, of reasoning.

Other mathematicians and symbolic logicians have since then considerably improved and extended the algebra which Boole devised.

Ideas of Boolean algebra

What are the ideas of Boolean algebra? In Chart 1 is a comparison of the main features of:

Elementary algebra, which we all learn in school, for handling numbers, and which is essential for all computations in radio, electronics, electricity, etc., and

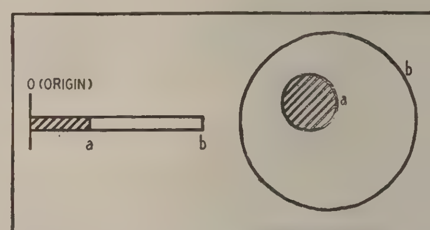
Boolean algebra, the newer algebra, which is useful for handling statements, classes, conditions, and circuit elements.

A great deal of information has been packed into this chart, and it is worth much attention.

A reader may say: "There seem to be two ways in which Boolean algebra can be represented, by classes and by the truth values of statements." Yes —and there are more ways besides. Boolean algebra is an interesting mathematical framework that applies to quite a variety of different situations.

For example, take the number 30 and its factors 1, 2, 3, 5, 6, 10, 15, 30; let a, b, c, . . . be any factors; let $a \vee b$ mean the least common multiple of a and b; let $a \cdot b$ be the highest common factor of a and b; and a' be $30/a$. You will find this to be a Boolean algebra.

For another example, consider sets of contacts, switches or relays; let a, b, c, . . . be any switch contacts; $a = b$ if a is closed when b is closed and open when b is open; $a \vee b$ means a and b in parallel; $a \cdot b$ means a and b in series; and a' is any contact open when a is closed and closed when a is open. This is typical Boolean algebra. How it is applied in practical electric circuits will be shown later.



The drawings above indicate what *a* and *b* mean in standard and Boolean algebra.

Rules of Boolean algebra

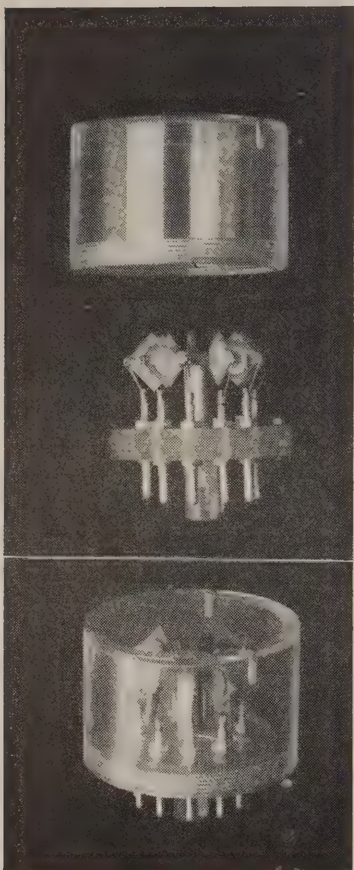
But the ideas of Boolean algebra, interesting though they may be, are not enough: we also need the rules. We could work out the rules on the basis of ordinary reasoning. In fact, most ordinary reasoning is Boolean algebra and is done by means of words and experience. But the rules of Boolean algebra expressed in mathematical form are potent and helpful. They are given in Chart 2, set into comparison with the rules of ordinary elementary algebra.

Here then is an introduction to the ideas and rules of Boolean algebra. Some of the ways to use them for dealing with circuit elements that can be "on" or "off," and some of the ways to use them for connecting input and output to express the behavior of a robot or mechanical brain, will be explained in the next article.

—end—

CHART 2—THE RULES OF BOOLEAN ALGEBRA

TOPIC	ELEMENTARY ALGEBRA	BOOLEAN ALGEBRA
1. Commutative Law	$a + b = b + a$ a PLUS b = b PLUS a $a \cdot b = b \cdot a$ a TIMES b = b TIMES a	$a \vee b = b \vee a$ (a OR b) = (b OR a) $a \cdot b = b \cdot a$ (a AND b) = (b AND a)
2. Associative Law	$(a + b) + c = a + (b + c)$ a PLUS b PLUS c is the same, whatever order you take them. $(a \cdot b) \cdot c = a \cdot (b \cdot c)$ a TIMES b TIMES c is the same, whatever order you take them.	$(a \vee b) \vee c = a \vee (b \vee c)$ a OR b OR c is the same, whatever order you take them. $(a \cdot b) \cdot c = a(b \cdot c)$ a AND b AND c is the the same whatever order you take them.
3. Distributive Law	*ONE LAW:* $a \cdot (b + c) = ab + ac$ a TIMES (b PLUS c) = (a TIMES b) PLUS (a TIMES c)	*TWO LAWS:* (1) $a \cdot (b \vee c) = a \cdot b \vee a \cdot c$ a AND (b OR c) = (a AND b) OR (a AND c) (2) $a \vee (b \cdot c) = (a \vee b) \cdot (a \vee c)$ a OR (b AND c) = (a OR b) AND (a OR c)
4. Combining	$a + a = 2a$ a PLUS a = TWO a $a \cdot a = a^2$ a TIMES a = a SQUARED There are numerical coefficients and exponents.	$a \vee a = a$ a OR a = a $a \cdot a = a$ a AND a = a There are *no* numerical coefficients or exponents.
5. Special Elements	0, ZERO; 1, UNITY $a + 0 = a$ $a \cdot 0 = 0$ $a + 1 = a + 1$ $a \cdot 1 = a$	0, NULL, NOTHING; 1, UNIVERSE, ALL $a \vee 0 = a$ (a OR NOTHING = a) $a \cdot 0 = 0$ (WHAT IS BOTH a AND NOTHING = NOTHING) $a \vee 1 = 1$ (a OR ALL = ALL) $a \cdot 1 = a$ (BOTH a AND ALL = a)
6. Opposites	*TWO OPPOSITES:* $a + (-a) = 0$ a PLUS (MINUS a) = 0 $a \times (1/a) = 1$ a TIMES (RECIPROCAL OF a) = 1 $-(-a) = a$ $1/(1/a) = a$	*ONE OPPOSITE:* $a \vee a' = 1$ a OR NOT a = ALL $a \cdot a' = 0$ BOTH a AND NOT a = NOTHING $(a')' = a$ (NOT–NOT–a = a) $1' = 0$ $0' = 1$
7. Laws Involving Opposites	$a + b = -(-a - b)$ $a \cdot b + a(-b) = o$ $-(a + b + c \ldots) = (-a) + (-b) + (-c) + \ldots$	$a \vee b = (a' \cdot b')'$ a OR b = NOT (NOT –a and NOT –b) $a \cdot b = (a' \vee b')'$ $a \cdot b \vee a \cdot b' = a$ $(a \vee b) \cdot (a \vee b') = a$ $(a \vee b \vee c \ldots)' = a' \cdot b' \cdot c' \ldots$
8. Absorption	$a + ab = a(1 + b)$ $a(a + b) = a^2 + ab$	$a \vee (a \cdot b) = a$ a OR (a AND b) = a $a \cdot (a \vee b) = a$ a AND (a OR b) = a
9. Relation of Less Than or Included In	*LESS THAN OR EQUAL:* $a \leqq b$ if and only if $a +$ (zero or some positive number) $= b$	*INCLUDED IN (LIES IN):* $a \subset b$ if and only if: $a \vee b = b$, or $a \cdot b = a$, or $a \cdot b' = 0$, or $a' \vee b = 1$



Multiple holdover for 10 overtone units.

Harmonic Oscillators

Photo Courtesy of Western Electric Co.

By **NORMAN L. CHALFIN**

DIRECT crystal-controlled oscillators at 50 megacycles have been available commercially for the last few years. They have been rather expensive. This is a necessary result of the great care required in their manufacture.

Mason and Fair[1] first demonstrated direct crystal-controlled v.h.f. oscillators in 1942. The circuits and the crystal units were of special construction as shown in Fig. 1. Their physical appearance was somewhat as in 1-a and their equivalent bridge circuit is shown in 1-b. The basic idea was that when the holder and crystal capacitances were balanced out at a frequency near an odd harmonic of the crystal thickness frequency, the crystal circuit placed in the output-to-grid feedback path of an oscillating circuit will control the oscillator at an odd crystal harmonic (Fig. 1-c). The fascinating point of this arrangement is that the fundamental is not present, nor is any other related frequency below the desired odd harmonic.

To appreciate the mechanical nature of the phenomenon that makes the harmonic-mode crystal oscillator possible, one must first observe the operation of a crystal oscillator plate of the familiar AT or BT cut. In Fig. 2 is shown the motion an oscillating crystal of this type undergoes. Note that the action is a forward motion of the top surface while the bottom surface moves backward, pivoting at the center. This would be one half-cycle. The second half-cycle will have the forward motion in the bottom half and the backward motion in the top half.

The motion described is *thickness-shear vibration.* The result is a piezoelectric polarity as shown in the figure. Now picture the same crystal with its thickness divided by three as shown in Fig. 3. In the harmonic-mode oscillator the shear vibration breaks up this way. A fifth harmonic oscillation will show a breakup of five sections of equal thickness, a seventh harmonic oscillation seven sections, and so on. This harmonic excitation occurs only at the odd harmonics. You can see why it is that the even harmonics are not possible if you examine the breakup diagram in Fig. 3. Note the upper pair of sections and see that if they alone made up a crystal the polarity of the opposite surfaces would be the same. For a piezoelectric crystal to sustain oscillation, the piezoelectric polarities of the opposite surfaces must be of opposite sign. At any odd number of thickness-shear breakups the opposite faces will always have opposite piezoelectric polarities.

Some overtone circuits

The simplest of the harmonic-mode oscillating circuits is the familiar plate-tuned crystal oscillator shown in Fig. 4-a. While the author has never suc-

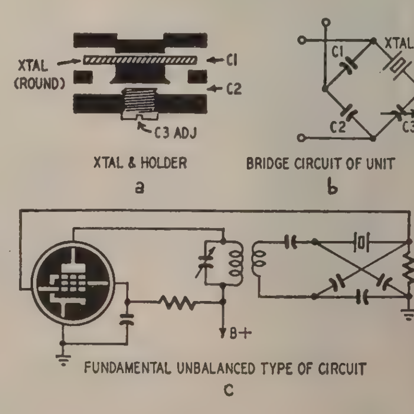


Fig. 1—Basic Mason and Fair circuit.

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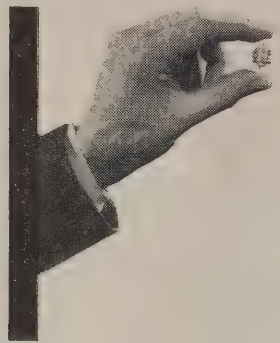

ceeded in getting this arrangement to work above the third harmonic without difficulty, Lister reports it is easily possible with the circuit shown in Fig. 4-b. The plate circuit is tuned to three or five times the crystal frequency, according to Lister[2]. The circuit will oscillate at the plate-tuned frequency. The circuit in Fig. 4-a is used by many amateur operators in their transmitters. There is one precaution to take. The circuit capacitances must be at a minimum on the crystal input or grid side. If the Lister circuit is used above the fifth mode the capacitor C1 across the coil which parallels the crystal should be its own self-capacitance. This circuit also has a tendency toward self-oscillation at higher frequencies.

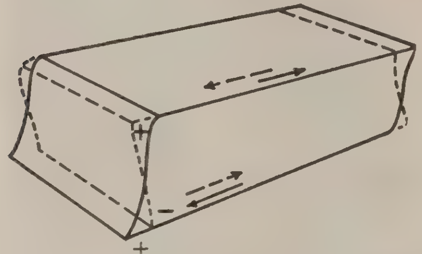

Fig. 2—Shear mode, AT and BT crystals.

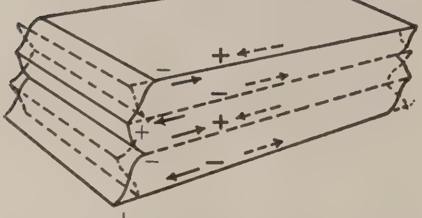

Fig. 3—3rd harmonic shear vibration.

Higher order harmonic-mode crystal oscillators are more readily built with an oscillator exciting the crystal as part of the oscillator circuitry. An example of this method is shown in Fig. 5. The L1-C1 combination is tuned to odd harmonics (3, 5, 7, etc.) of the crystal fundamental, and L2-C2 to double or triple the frequency of L1-C1. Cb is a balancing capacitor, and may run from about 1.5 to 7 μμf. The circuit of Fig. 6 is of similar design. It was developed by Thurston[3] of Bell Labs for v.h.f. radiophone use. Ham frequencies (see Table I) can easily be excited with these circuits. The two circuits are similar in operation. The bridge shown in Fig. 5-b breaks down the circuit arrangement for easier analysis. When the crystal-holder capacitance and the combination of the tube input capacitance and an externally adjustable capacity Cb are in balance with the two halves of the coil representing the other legs of the bridge, the circuit will not oscillate except where the circuit element representing the crystal becomes a low impedance, at for example, an odd harmonic resonant frequency of the crystal's normal oscillating frequency.

Adjusting the oscillator

When the circuits of Figs. 5 and 6, and the original Mason and Fair circuits, are employed, the first step in their adjustment requires balancing the capacitances. The adjustment point for Cb is just below where self-oscillation occurs. A grid-current meter will show the point at which oscillation just ceases. The crystal—or an equivalent capacitance to the crystal-holder capacitance—should be in the circuit during the balance adjustment. Tune the L-C circuit for the desired crystal resonance. The proper operation will be shown by a rise in grid current or a dip in plate current. A coil with 3–1 frequency range will make possible tuning a nominal 7-megacycle crystal to 21 mc, 35 mc, 49 mc, or 63 mc in the harmonic oscillator.

There is shown in Fig. 7 a group of circuits basically operating on the same

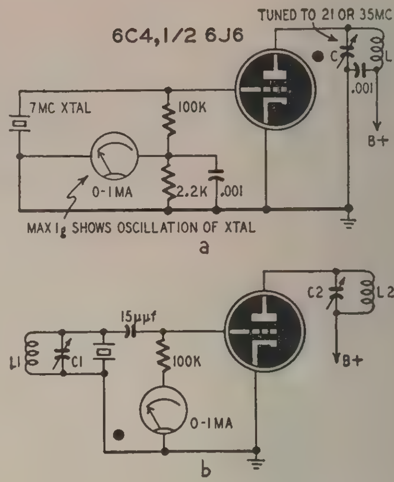

Fig. 4—Harmonic oscillation circuit.

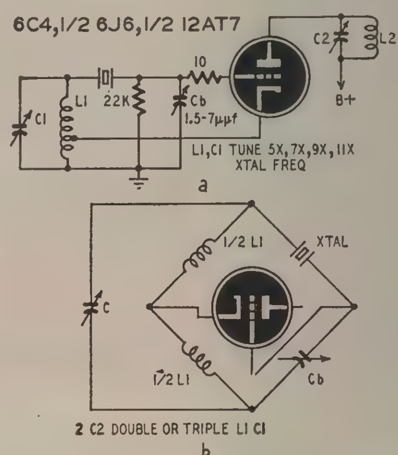

Fig. 5—An excited overtone circuit.

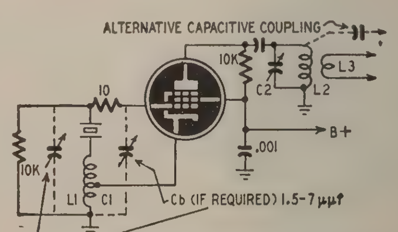

Fig. 6—Thurston harmonic oscillator.

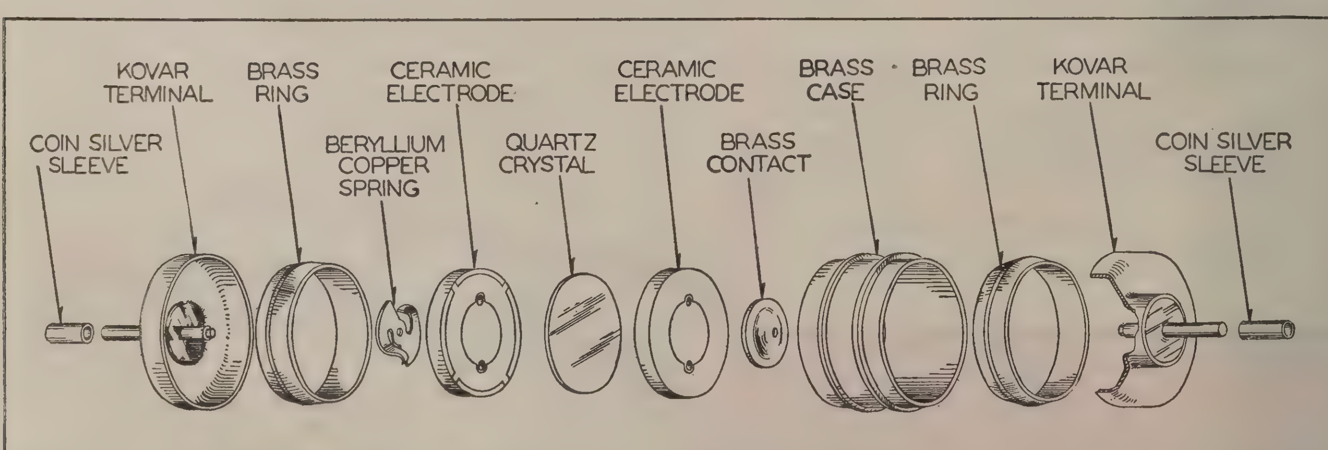

Fig. 7—The Bell Telephone Laboratories crystal unit, D-153053 or CR-9, gives direct crystal control from 15 to 50 mc.

principle as those described above. The variations are in the types of oscillators

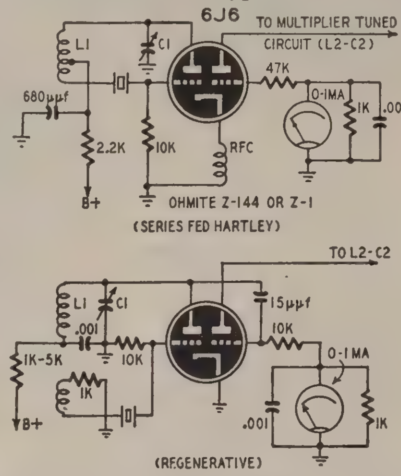

Fig. 7—Variations of Fig. 5 use cathode or capacitance coupling to isolate multiplier from harmonic mode oscillator.

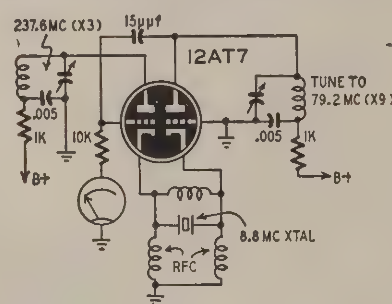

Fig. 8—A cathode coupled oscillator.

employed to excite the crystal. Choice of the type of oscillator is a matter of establishing, after experiment, which of the circuits best serves the user's purpose. Another circuit is shown in Fig. 8. The latter variation is of the cathode-coupled oscillator circuits.

Advantages of overtone crystals

The advantages of using the harmonic-mode crystal oscillators should be obvious. With circuits of the type illustrated in Figs. 5, 6, and 7, multiplication factors of the order of 33 are possible in a single tube. In the table of amateur frequency applications we have indicated use of the 27th harmonic of a nominally 8.8-mc crystal. Saving in tubes and components is great. Closer tolerance possible with crystal control makes more channels usable. Reduction of various interaction effects—prevalent when multiplication of the familiar type is employed—is the most important factor in the usefulness of harmonic-mode oscillators, particularly when used for receiver-control crystals. Both in receiver and transmitter applications of harmonic-mode crystal units the absence of "birdies" and the other undesirable beat-note effects is a practical feature of the technique.

A complete transmitter or receiver oscillator arrangement utilizing harmonic-mode oscillator, plate-tuning multiplier, and an unusual frequency doubler employing a single oscillator tube and a pair of crystal diodes is shown in Fig. 9. The greatest useful-

TABLE OF NOMINAL CRYSTAL FREQUENCIES AND HARMONIC-MODE OSCILLATOR RANGES IN THE AMATEUR BANDS

Amateur Band (megacycles)	Nominal Thickness Frequency (megacycles)	Harmonic Mode Used	Circuit
14.0–14.4	4.666 to 4.800	3×	Figs. 4, 5, 6
26.96–27.23	8.986 to 9.076	3×	Figs. 4, 5, 6
	5.392 to 5.446	5×	Figs. 5, 6, 7
28.0–29.7	9.333 to 9.900	3×	Figs. 4, 5, 6
	5.6 to 5.4	5×	Figs. 5, 6, 7
50–54	10.0 to 10.8	5×	Figs. 5, 6, 7
	7.143 to 7.714	7×	Figs. 5, 6, 7
	5.555 to 6.000	9×	Figs. 5, 6, 7
144–148	10.286 to 10.571	7× (×2) = 14	Figs. 5, 6, 7 + Multiplier
	8.0 to 8.444	9× (×2) = 18	Figs. 5, 6, 7 + Multiplier
220–225	10.000 to 10.227	11× (×2) = 22	Figs. 6, 7 + Multiplier
	10.048 to 10.429	7× (×3) = 21	Figs. 6, 7 + Multiplier
235–240	10.673 to 10.909	11× (×2) = 22	Figs. 6, 7 + Multiplier
	8.704 to 8.888	9× (×3) = 27	Figs. 6, 7 + Multiplier
420–450	7.777 to 8.333	9× (×2) (×3) = 54	Figs. 6, 7 + Multiplier + Tripler

ness for this arrangement is probably to be found for receiver applications in the u.h.f. region. The identical circuit has been used in experimental TV local oscillator control.

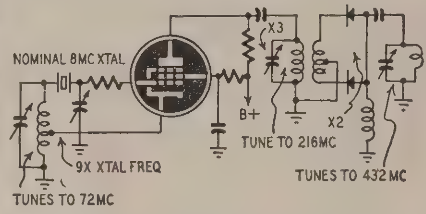

Fig. 9—432-mc output with 8-mc crystal CR-9 units, operating at 40 and 45 mc.

Photographs are shown of a crystal-holder assembly developed for multiple frequency selection such as in a TV tuning turret, applying harmonic-mode oscillators. Wherever many frequencies are required, as in a multichannel receiver, a holder of this type is useful. The author has constructed FM receivers and TV receivers, [4], [5], employing harmonic oscillator circuits. Reference is made to these in the bibliography.

Any carefully made crystal of the AT or BT cut works in a harmonic oscillator under the proper conditions. Circuits must be wired with care and the well-known techniques of high-frequency construction must be observed. The crystal must have very flat surfaces and very rectangular edges for best results. Acid-etched surfaces have been found better for harmonic-mode crystals than abrasive-ground surfaces.

—end—

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[2] Lister, **Overtone Crystal Oscillator Design,** *Electronics*, Nov., 1950, p. 88.

[3] Thurston, **Direct Crystal Control at 50 Megacycles,** *Western Electric Oscillator*, July, 1946, p. 30.

[4] Chalfin, **Crystal Stabilization of Television Receivers,** *Radio-Electronic Engineering Section, Radio News*, May, 1946, p. 9.

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Transistor Amplifier Circuits

By I. QUEEN

TRANSISTORS have been improved remarkably since they were first developed just a few years ago. They are now available to experimenters (at $15 to $18 apiece) and will, no doubt, find wide use in the future.

The unusual properties of the germanium crystal are due to impurities. Some, like antimony or arsenic, cause it to release excess electrons. Such crystals are called N-type. Other impurities, like aluminum, cause the crystal to absorb electrons. These crystals are P-type.

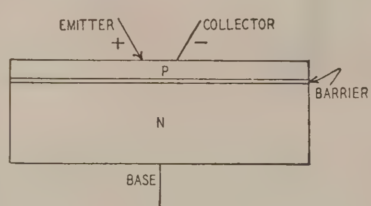


Fig. 1

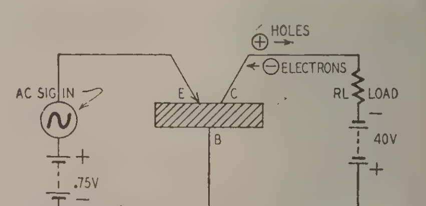
The conductivity of N-type germanium is due to electrons which are free to hop from atom to atom under the force of an electric field. P-type germanium conducts because of the "holes" or atoms which have lost electrons.

A typical transistor may be made of a small block of N-type germanium approximately .05 inch square and .02 inch thick. One surface is heat-treated to give it P characteristics. The other surface is metal-plated for low resistance. This becomes the base of the transistor.

Two catwhiskers 2 or 3 mils apart contact the P surface. One (called the emitter) is biased positively with respect to the base. The other is negative—the collector—(See Fig. 1.)

The positive potential on the emitter repels holes into the P layer. These diffuse through the layer which has lower resistance than the barrier. Since the base is negative it partly neutralizes the positive charges on the P surface. The greater the voltage between emitter and base, the more holes diffuse through the P surface. The base then neutralizes more of the positive space charge and permits greater flow of holes.

Holes moving away from the emitter flow laterally through the P zone and may come under the influence of the collector. Therefore they flow into the load circuit (Fig. 2). The concentration of charges near the collector reduces the potential near this area and may also permit the flow of electrons in the high-voltage circuit between collector and base. The combination of electrons moving out of the collector and holes moving into it constitutes the total collector current. The ratio of collector current to emitter current depends upon the construction of the transistor and the circuit in which it is used.



EMITTER ARROW POINTS TOWARD TRANSISTOR TO DENOTE N-TYPE

Fig. 2

A new transistor type is now being developed at Bell Telephone Laboratories. It is called the N-P-N-type. It consists of a single piece of germanium, each end of which has N-type conductivity. Between them is a thin P-type layer less than .001 inch thick (Fig 3). Like any P-type transistor, this one requires a negative emitter and a positive collector.

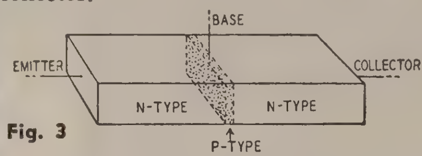


Fig. 3

This transistor has improved gain and noise characteristics. It operates with very low collector input. In class A its efficiency approaches the theoretical limit of 50%. Collector input may be anything from 0.1 to 39 volts and between 20 microamperes and 5 milliamperes.

The N-P-N can give a gain of over 44 db up to a limit of 3.4 kc. Response may be maintained to 220 kc when the gain is reduced to 27.8 db (by decreasing input and output impedances). The new transistor is completely described in the Bell System Technical Journal, July, 1951.

Compare the operation of a vacuum tube and a transistor. In a transistor, the emitter is the source of charged particles. As the particles move away they are controlled by the voltage between emitter and base. The collector gathers them and they flow to the output circuit. Unlike the vacuum tube, the input circuit of a transistor has low impedance. Considerable power is absorbed from the signal source. The transistor is essentially a power amplifier.

Just as with tubes, there are three basic circuits for transistors. They are: grounded base, grounded emitter, and grounded collector. The word "grounded" signifies that an element is common with the other two. There need not be a direct connection with earth in any case.

Fig. 4 shows the grounded base circuit.

Fig. 5 shows the grounded-emitter circuit. With average constants the input impedance is greater and the output impedance smaller than in the previous circuit. This makes it convenient when matching for maximum gain. With ordinary values, this circuit can provide considerable current amplification and the output phase is reversed.

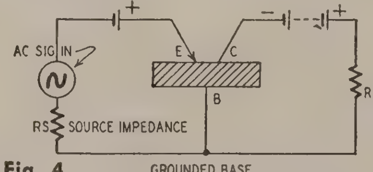


Fig. 4 GROUNDED BASE

A grounded collector or "cathode follower" is shown in Fig. 6. This can be used to give very low output impedance and relatively high input impedance. Amplification is essentially current since the output voltage is less than the input. Phase is not reversed.

In the various circuits shown above it may be noted that the emitter bias is rather inconvenient. It is generally a fraction of a volt and very critical. For this reason efforts have been made to eliminate need for a separate bias supply.

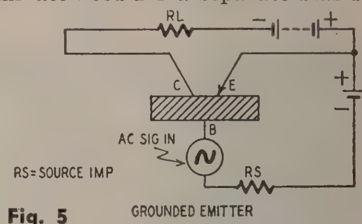


Fig. 5 GROUNDED EMITTER

An effective method has been invented by H. L. Barney and R. C. Mathes.* These circuits are shown in Fig. 7.

The high voltage between collector and base results in a small current flow

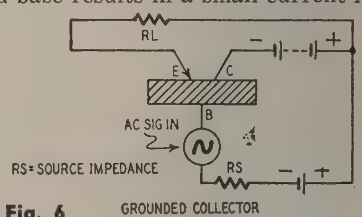


Fig. 6 GROUNDED COLLECTOR

of about 2.5 ma between the elements. Electrons flow from collector to base within the transistor. In Fig. 7-a, a resistor R1 is connected in the base circuit and bypassed for signal currents. It sets up a bias voltage with polarity as shown. If R1 is about 300 ohms, the bias will be about 0.75 volt, which is usually satisfactory.

Fig. 7-b shows a grounded collector circuit. The bias resistor R1 is used as described in the previous circuit. A grounded-emitter circuit is shown in 7-c.

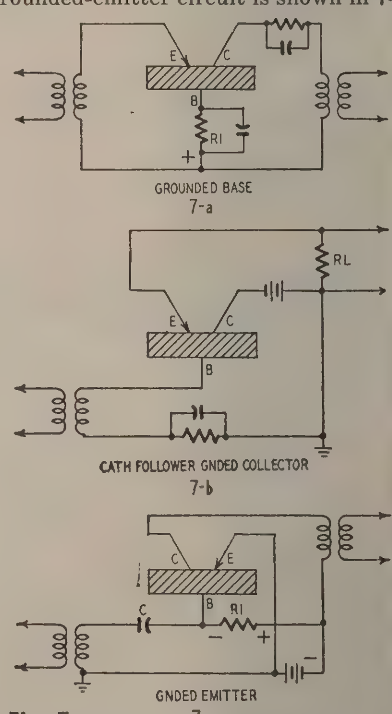


Fig. 7

A capacitor C blocks the base. Base current therefore flows through R1 and sets up the required bias. This resistor may be several hundred thousand ohms and should not be bypassed.

*Patent No. 2,517,960

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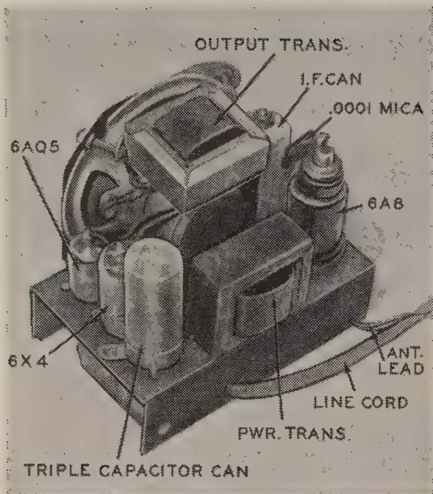
A Scotsman's Superhet

By JOHN W. STRAEDE



Junior-sized chassis packs all parts.

I WONDER how many "Scotch" sets have been described! Since the early twenties, economically minded set designers have turned out the Scotsman's one-valver, his 2-tuber, his 3-tuber, etc. Well, here's a baby superhet that's fairly inexpensive and has a number of interesting features. It operates a loudspeaker on locals, and some of the stronger short-wave stations also can be received at reasonable speaker strength. The usual radiation, an antisocial feature of most regenerative receivers, is absent, as regeneration is limited to the second detector. No regeneration adjusting is required when tuning the receiver, as the amount of feedback is fixed. The set therefore is simple to operate and is compact.

Economy is achieved by having no padder, no trimmer, no aerial coil, no intermediate-frequency stage, and only three tubes (two if a dry rectifier is used). See Fig. 1. If you buy a loudspeaker for the job, get one with long leads (you won't have to buy any hookup wire).

Tube functions

Although sensitivity is somewhat low due to the lack of i.f. stage and untuned aerial circuit, it is not as low as might at first be feared. The second detector is a real "power" detector using a 6AQ5, midget equivalent of the 6V6. It performs three functions: i.f. amplifier because it is regenerative; diode detection, the grid and cathode acting as a diode; and a.f. power output. About 1 to 1½ watts is obtained with a high voltage supply of 250 volts. Combining these functions enables a smaller rectifier to be used.

The second tube operates under conditions of high sensitivity, high anode load (25,000 ohms) and low grid bias (bias is due to the rectification of the i.f. signal applied to the grid).

Regeneration

Fixed regeneration is obtained by linking the anode of the output tube through a small capacitor to the anode of the converter tube. The capacitor is extremely small and consists in practice of a "gimmick"—a length of insulated hookup wire, each end of which is looped once around the leads from each of the anodes. Possibly a double loop may be required if the Q of the i.f. transformer or the line voltage and therefore B-voltage is low. This regeneration does not usually have to be adjusted to a maximum; only a small amount is required. In some locations none at all may be needed unless short-wave operation is required

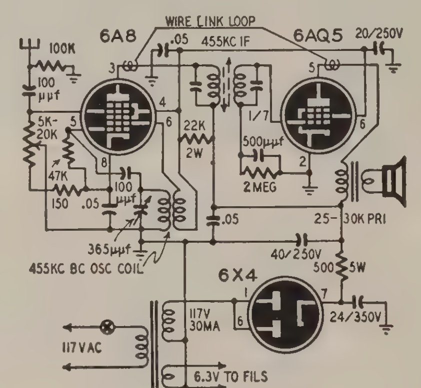


Fig. 1—The basic superheterodyne set.

If the set is to be used seriously for short-wave reception, a regeneration control is advisable (Fig. 2) so that the set can be kept at maximum sensitivity. (The set shown is for broadcast band only but other models had plug-in coils.)

Pepping it up

Greater sensitivity for short-wave reception can be obtained by increasing the plate load of the output tube. Even 55,000 ohms can be used for B-plus supplies as low as 100 to 125 volts and 30,000 ohms for supplies up to 250 volts. Too high a load may cause sparking at the tube pins or a breakdown in the speaker transformer.

Another way to obtain a slight rise in sensitivity is to use audio-frequency regeneration (in addition to i.f. regeneration!), on the output tube. The necessary feedback, see Fig. 3, is obtained by grounding one side of the secondary of the speaker transformer (and of course the voice coil), and connecting the *cathode* of the output tube to the other side.

If such an alteration results in a decrease in volume, then reverse the transformer secondary. This positive feedback causes only a very slight increase in distortion (usually not even noticeable).

Component size

Midget tubes and small parts are used. The speaker is a PM job. A midget variable capacitor using a solid dielectric of plastic, saves space, but an air-dielectric capacitor is advisable if short-wave reception is required.

Further space could have been saved by omitting the 6.3-volt filament transformer and using a 12A8-GT and a 50L6-GT as tubes with a series resistor.

In any version of this circuit careful alignment of the single i.f. transformer is necessary to avoid whistles, a common fault in any superhet that has no tuned circuit before the converter. Fig. 4 shows how to connect parasitic suppressors to prevent whistles.

Materials for baby superhet

Resistors: 1—2 megohms, 1—100,000, 1—47,000, 1—150 ohms, ½ watt; 1—22,000 ohms, 2 watts; 1—500 ohms, 5 watts. Potentiometers: 1—5,000-20,000 ohm. **Capacitors:** (Mica) 2—100, 1—500 µµf. (Paper) 3—.05 µf, 250 volts. (Electrolytic) 1—triple unit, 20, 40 µf, 250 volts, 1—24 µf, 350 volts. **Miscellaneous:** Tubes. 1—6A8, 1—6AQ5, 1—6X4. Tube sockets. Coils (see text). 1—6.3-volt power transformer, 2 amperes. 1—Speaker, 25,000-30,000-ohm primary, 6-8-ohm secondary. Chassis. Hardware. Solder. Wire.

—end—

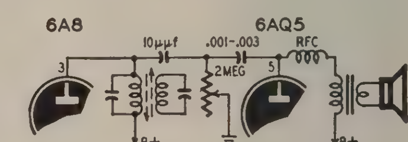


Fig. 2—Circuit for r.f. regeneration.

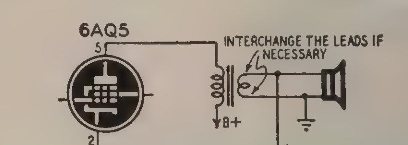


Fig. 3—Positive feedback aids gain.

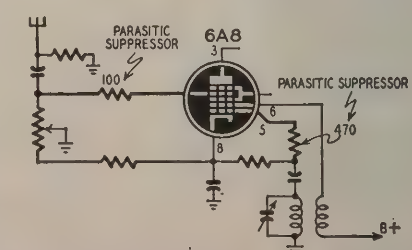
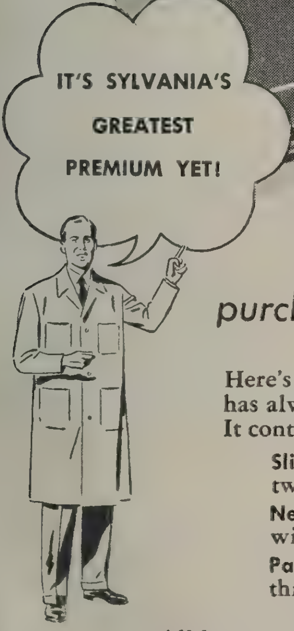


Fig. 4—Suppressors help kill birdies.

Now this precision-matched miniature Pliers Kit yours *FREE*



...with every 100 Sylvania Receiving Tubes or 3 Picture Tubes purchased between Nov. 15th and Dec. 15th

Here's exactly the tool kit every radio and TV serviceman has always needed. A complete miniature pliers kit. It contains:

Slip-Joint Pliers: 4¾ inches long with adjustable two-position slip-joint.

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All have precision-matched jaws with finely-milled teeth, forged from the finest steel by a leading manufacturer of surgical instruments. Regular $4.50 value!

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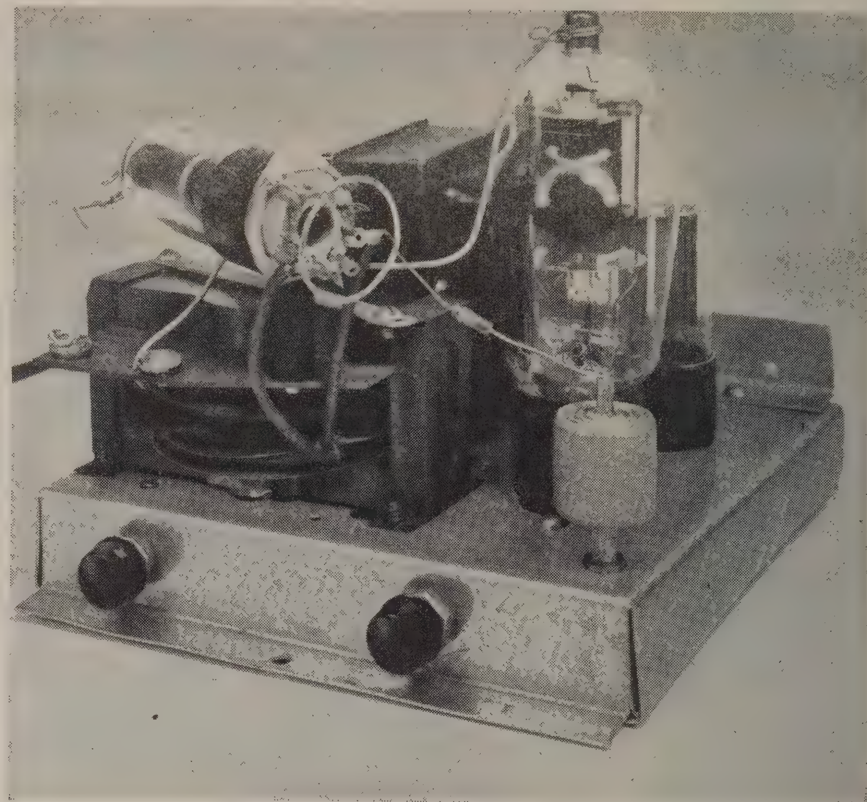


Using less than 60 watts of power and standard TV components and tubes this handy little unit can put out fourteen kilovolts with plenty of microamperes.

TV Components Make This 14-KV Generator

By HAROLD PALLATZ

A few of the uses of these power supplies are: electrostatic paint spraying, dust removing, electret charging, and breakdown testing of television components.

Electrostatic paint spraying operations in industry are in much demand. The hookup is simple. A high potential is applied between the muzzle of the sprayer and the object to be painted. The fine paint particles which ordinarily were lost are now attracted to the object, their paths being changed so that none are wasted. Paint savings may amount to hundreds of gallons to a large manufacturer. A more even and smoother coating is achieved at the same time.

Dust removing is a necessity in hospitals and in many factories. Filtering methods which use fine-mesh screens result in restriction of the flow of the air. By arranging many pairs of parallel plates, each of which is highly charged, any particles of dust in the air stream are immediately pulled by electric fingers to the plates. The clean air flows freely between them. The instruments you are now using in your shop may well owe part of their trouble-free operation to use of one of these electrostatic dust removers in the factory where they were made.

For the experimenter

For those of us who like to experiment and tinker a little, a high-voltage power supply finds many applications. A Kerr cell (light modulator) will operate directly off the output of the supply. By proper switching circuits, a fast-acting electronic camera shutter can thus be made. Electret construction and charging requires high potentials. The adjustable output feature of these power supplies will prove handy for this task. The upper limit of 14 kilovolts should be sufficient to meet most size and charge requirements.

Instruments should be tested and calibrated at the conditions under which the equipment is designed to operate. The direct comparison of kilovoltmeters is a simple task with these power supplies. Instruments can be checked against a meter which is built into the power supply or compared against others of known accuracy. The fineness that the voltage output may be set to will help in these tests. Make sure that both instruments are grounded properly.

German crowd, part of the 1,250,000 from East and West Berlin, sees a typical RCA television program.

"Freedom's window in the Iron Curtain"

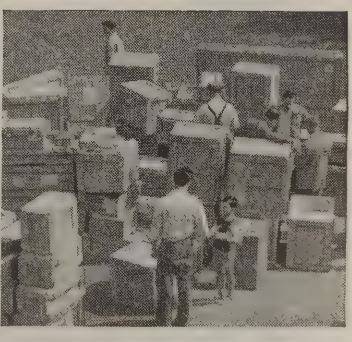
You've read the story of last summer's TV demonstrations in Berlin. It attracted a million and a quarter Germans—including thousands who slipped through the Iron Curtain to see Western progress at work.

Behind this is another story: How RCA engineers and technicians broke all records in setting up these Berlin facilities. The project called for a TV station and studio, a lofty batwing antenna, and the installation of 110 television receivers at strategic points. Such a program would normally take several months to complete. It was installed and put to work by RCA in a record-breaking 85 hours!

Programs witnessed by Berliners included live talent shows, sports events, news commentaries, and dramatizations of the Marshall Plan. Observers pronounced reception fully up to American standards—another impressive demonstration of democracy's technical ingenuity and leadership.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, N. Y. 20, N. Y.



Part of the 401 cases of RCA equipment shipped to Berlin for television demonstrations.

RADIO CORPORATION of AMERICA
World Leader in Radio—First in Television

Breakdown tests can be made of television parts while actually mounted in the set or on the bench. For all such tests, a resistor of approximately 1 megohm should be connected in series with high-voltage terminal. Breakdown can be observed either visually or with a neon bulb or voltmeter.

The high-voltage power supply

Our high voltages are obtained by using a flyback (television horizontal output) transformer. It works both as the oscillator and the high-tension transformer. To secure d.c. output we use a 1B3-GT rectifier tube. This tube *cannot* be replaced by a 1X2. The 1X2 is a fine, well-designed tube, but cannot stand up well in the severe service demanded by experimental voltage supplies.

The oscillator (Fig. 1) is fed by a simple power supply which delivers d.c. Several attempts were made to secure operation directly off the raw a.c. from the power transformer. All resulted in lowered high-tension output or excessive tube heating.

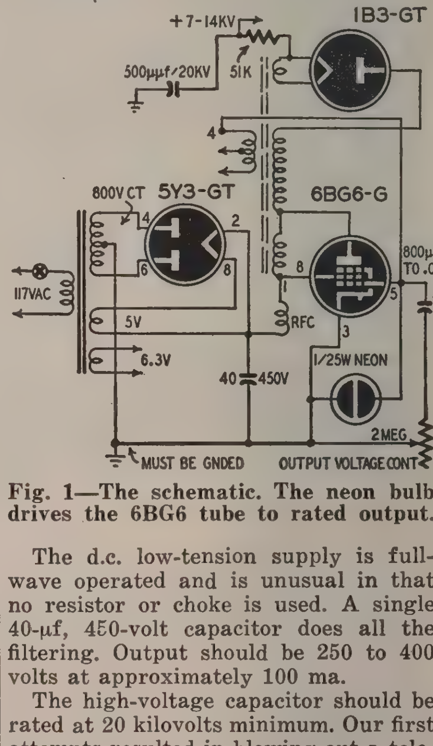


Fig. 1—The schematic. The neon bulb drives the 6BG6 tube to rated output.

The d.c. low-tension supply is full-wave operated and is unusual in that no resistor or choke is used. A single 40-μf, 450-volt capacitor does all the filtering. Output should be 250 to 400 volts at approximately 100 ma.

The high-voltage capacitor should be rated at 20 kilovolts minimum. Our first attempts resulted in blowing out a television capacitor rated at 10 kilovolts. Capacitance is 500 μμf, which provides sufficient filtering for most applications. If very large capacitors such as photoflash types are used, a resistor should be placed in series to prevent excessive current drains through the 1B3-GT tube.

The socket of the 1B3-GT must have a corona ring (see photo), and its insulation to ground should be adequate for the voltages. Most plastics such as plexiglas, bakelite, lucite, etc., will do very well. Ceramic insulators are also useable. None of the socket-prong clips should extend beyond the ring.

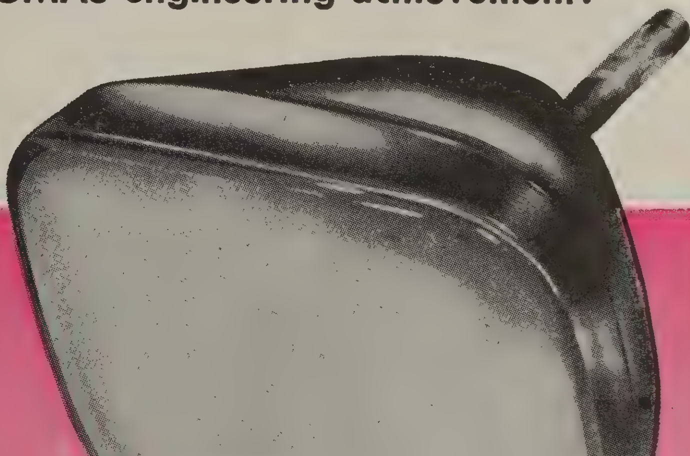
Dust particles will be attracted to all the high-potential points. Clean these areas regularly to prevent excessive leakage.

This is it!

the NEW Thomas

Automatic Selfocusing Phototron picture tube . . .

available with sensational glare-reducing cylindrical surface face plate...the latest THOMAS engineering achievement!



THOMAS Automatic Selfocusing Phototron picture tube . . . replaces either electromagnetic—or electrostatic—focusing tubes. Gives sharp focus edge-to-edge for the entire tube life . . . without focus deterioration.

THOMAS Automatic Selfocusing Phototron picture tube . . . requires no focusing circuits or components. And is directly replaceable without circuit changes.

THOMAS Automatic Selfocusing Phototron picture tube . . . reduces service calls resulting from line voltage, or anode voltage fluctuation; plus call-backs due to faulty potentiometers and focusing devices.

Illustrated is the THOMAS 21 inch Automatic Selfocusing Phototron picture tube with glare-reducing cylindrical surface face plate. The selfocusing feature is available in other sizes and types.

Contact your jobber or distributor for the complete THOMAS Phototron line . . . or write THOMAS direct.

Exact

Thomas ELECTRONICS Inc.
PASSAIC, NEW JERSEY

TEI

Lick stubborn cases of corona discharge by applying several coats of polystyrene cement to the offending surfaces and letting dry fully before applying power.

Meter circuits

Microammeters with a number of high-resistance series-multiplier resistors may be wired across the output terminals to show actual output voltage. The meter itself must be at the *ground* terminal. Stray r.f. fields must not be present near the meter, or damage to the meter, shock, or improper

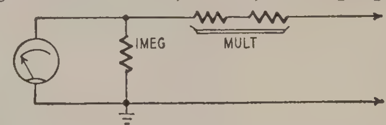


Fig. 2—Circuit for metering the generator. Ground the case of the meter!

readings may result. The meter should of course load the circuit as lightly as possible. We suggest a 0–25-microampere movement. The circuit appears in Fig. 2. For a 25-μa movement the multiplier MULT should be 600 megohms; for a 50-μa movement, 300 megohms. Although our circuit uses a 6BG6 tube, you are by no means limited to this one type. The popular 807 and television horizontal output tubes should all work well. The circuits may vary somewhat with changes in tubes.

Output of the circuit shown in Fig. 1 is adjustable between 7 and 14 kilovolts. This may be doubled with a voltage-doubling circuit.

To secure these high potentials it is necessary to have the oscillator operate in a nonlinear mode. We secure this circuit requirement with a neon bulb in the grid circuit. Ionization of the bulb causes sharp voltage pulses in the grid circuit which build up the high potentials in the flyback transformer. A small pigtail 1/25-watt neon bulb does the job. The method of varying the voltage is quite simple, as only a rheostat and capacitor are required. These are connected across the neon bulb and change the grid-circuit operating conditions.

The type of oscillation has a marked effect on the breakdown of the flyback transformer. The transformer will

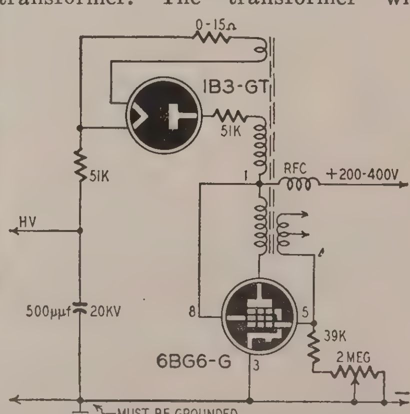
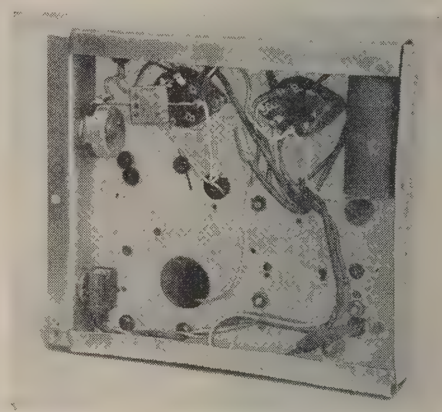


Fig. 3—A feedback oscillator circuit.

break down if the neon bulb is replaced with a resistor which approaches a critical value. Circuits can be constructed that use this principle instead of the neon bulb, but care must be observed in construction. (A suggested circuit appears in Fig. 3.) Grid coupling is accomplished by using one of the yoke taps on the transformer. Try all taps and select the best one. Usually the one marked "4" works best.

A small radio-frequency choke placed in series with the B-plus lead will improve the operation many times. The choke should be at approximately 8 millihenries and rated for 100 milliamperes. Use of choke depends upon the particular flyback transformer and tubes used.

As can be seen in the photographs, the layout and wiring is simple, and the supply can be put together quickly and easily. One word of warning! The chassis is shown "out in the open" for purposes of photographing. Don't try to use it that way! Keep it in a standard cage and keep it grounded as indicated in the schematic. Fourteen kilo-



There is little below-chassis wiring.

volts is not *always* lethal, but electronic Russian roulette is no game for the serious radio experimenter or television technician.

Materials for high-voltage supply

Resistors: 1—51,000 ohms, 1—2-megohm potentiometer.

Capacitors: (mica or high-quality paper) 1—800 μμf to .001 μf; (electrolytic) 1—40 μf, 450 volts; (high-voltage) 1—500 μμf, 20 kv.

Tubes: 1—6BG6-G, 1—1B3-GT, 1—5Y3-G or -GT.

Miscellaneous: 1—power transformer, 400-400 volts, 100 (or more) ma, 5 volts 3 amperes, 6.3 volts, 2 (or more) amperes; 1—flyback (horizontal output) transformer, 14-kv type; 1—neon lamp, .04 watt; 1—RFC, 8 mh app., 100 ma; sockets; chassis; cage; hardware; wiring; etc.

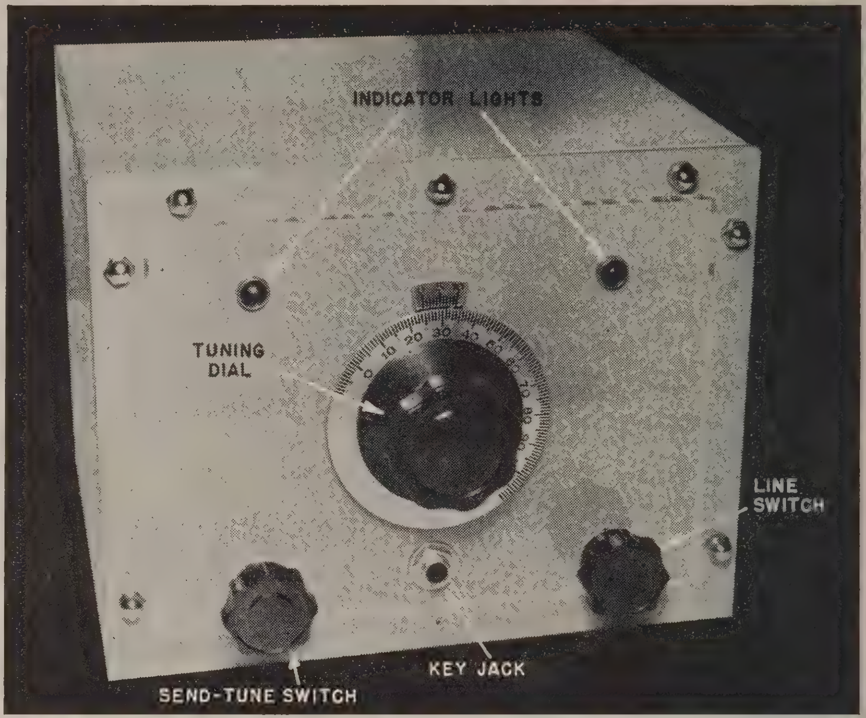
—end—

CORRECTION

We have been informed of two errors appearing on page 57 of the October, 1951, issue. The value of C2, of Fig. 2, specified as .05 μf is much too large to be considered as typical. The average buffer capacitor in a circuit of this type has a capacitance of about .005 μf and a working-voltage rating of 1,600 volts.

In the text, Fig. 6 is described as being a schematic of the model 110R10 Radiant Vipower. The correct name for this device is, of course, the *Radiart* Vipower. It is manufactured by The Radiart Corp., Cleveland, Ohio.

We thank Mr. Milton S. Roth, Jobber Sales Manager of Radiart, for these corrections.



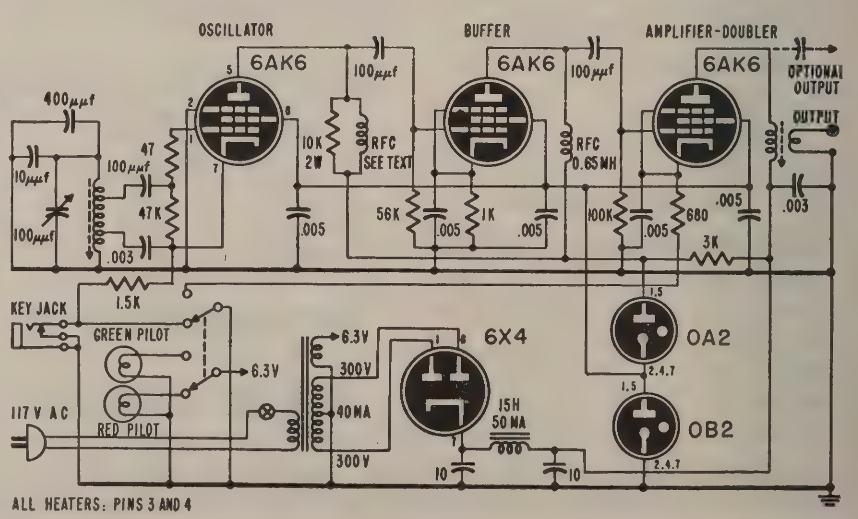
Front view of v.f.o. Both send-tune and off-on switches are of the rotary type.

Low-Drift VFO Allows Multi-Band Break-In

By OTTO L. WOOLEY

THE miniature tubes used throughout this v.f.o. permit a stable unit of moderate power output to be built in a minimum of space. The r.f. section consists of three 6AK6's: an electron-coupled oscillator, buffer and power amplifier stage. Compound voltage regulation is secured with an 0A2 and 0B2 complement, and the rectifier is a 6X4. In the unit shown the output is in the 80-meter band, but with plug-in coils could be used on any frequency desired. Following usual practice in this type of equipment, the oscillator operates on a submultiple of the output frequency and the output stage is a doubler.

Oscillator keying allows full break-in



The miniature-tube v.f.o. All coil details are fully explained in the text.

operation. With the circuit used, keying is crisp and clean. For good oscillator efficiency, the tube is operated with 255 volts on the plate, but total cathode current is held to a low 6.5 ma. Stability is improved by the resistor-loaded, broadly resonant choke in the plate circuit. This choke is constructed by scrambling about 275 turns of No. 34 d.s.c. wire on a 10,000-ohm, 2-watt composition type resistor (Ohmite "Little Devil" series or equivalent).

Note that the oscillator cathode is coupled for r.f. to the coil in the grid circuit through an .003-μf capacitor, while the d.c. return is made through the 1,500-ohm resistor. The oscillator grid tank is not required to carry any direct current, and is thus relieved of a possible heat source.

The buffer stage is operated at the same voltages as the oscillator. Its total cathode current is 8 ma. A 0.65-mh r.f. choke is used in its plate circuit.

The output tube is run with 325 volts on the plate and 105 on the screen, with a cathode current of 12 ma. Under these conditions the v.f.o. delivers sufficient r.f. to drive the usual crystal oscillator stage as an amplifier or as a doubler. A slug-tuned, low-C output coil provides substantially constant power across the operating range. The output link shown was selected to couple into the cathode circuit of the transmitter crystal stage. If it is desirable to feed a grid, the alternative capacitance coupling from the output plate may be necessary for full output.

The 0A2 and 0B2 tubes provide simple regulation for the oscillator and buffer plates and compound regulation for all the screens in the r.f. section. This makes the unit practically immune to any changes in supply voltage. The power supply employs full-wave rectification and capacitor input to the filter.

One feature will interest most operators; that is the tuning switch which makes it possible to spot the v.f.o. frequency in the receiver without putting the transmitter on the air. The position of this switch is shown by the indicator lamps on the front panel. These lamps also show when the a.c. supply is turned on. In the tuning position the oscillator is operating, the output tube cathode circuit is open, and the red indicator lamp is on. Throwing the switch to the sending position closes the output cathode circuit, puts the oscillator across the key, and lights the green indicator lamp. When used for phone operation the keying plug can be removed and the v.f.o. will operate under key-down conditions through the closed circuit jack. If break-in operation is not contemplated the design can be simplified by omitting the tuning switch and keying in the output cathode lead. (Keying in the output stage is somewhat less critical as to click filtering than oscillator keying.)

A 7 x 7 x 2-inch aluminum chassis is used for a foundation, with a 6 x 8-inch panel. The cabinet is made to fit the panel and is 7½ inches deep, folded

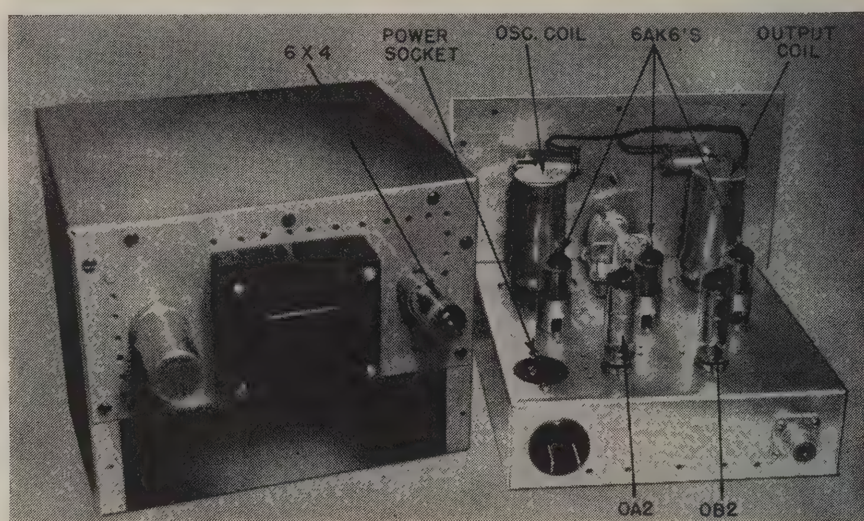
from sheet aluminum. Ventilation holes are drilled along the top and lower edges of the cabinet. The chassis is treated the same to allow the components mounted underneath to cool. The power supply is mounted externally on the rear of the cabinet where the heat will have little effect upon the frequency-determining elements. The general parts layout is apparent from the photographs, and provides very direct leads in all the critical portions of the circuit.

The oscillator padding capacitor is a 400-μμf, 2,500-volt mica taken from a TU-10 tuning unit. These seem to be very stable in all respects, and the threaded inserts make it possible to use machine screws for mounting. This makes the installation very solid. An insulating feedthrough bushing brings the hot capacitor lead through the chassis to the stator plates of the tuning capacitor.

Only a small amount of temperature compensation is necessary. It consists of a 10-μμf negative-coefficient Ceramicon mounted on the oscillator coil form inside the shield. The actual amount of compensation will vary with different units and can be determined only by experiment.

Final amplifier output is doubled in the output coil, consisting of 120 turns of No. 32 d.s.c. on the Millen 74001 form. The pickup link is 12 turns of 24 d.s.c. wound on the cold end. Do not ground the tuning-slug screw in this coil. It is desirable to keep coil-to-ground capacitance at a minimum.

A 6-prong socket is used to receive the plug from the power supply. At first glance it might appear that a rule of safety is being violated by having the plug on the power supply. However the socket supplies the a.c. to energize the supply so the method shown conforms to usual practice.



The power supply is so mounted as to minimize heating. Filter choke is inside.

The oscillator grid tank coil consists of 45 turns of No. 28 d.s.c. on a National XR-50 form mounted on a Millen 74001 base. Do not attempt to use the polystyrene form with which the Millen base is furnished. It expands and shifts the coil in relation to the tuning slug, thus causing a large frequency shift as the v.f.o. warms up. The coil is tapped 10 turns from bottom for the cathode lead and 12 turns from the top for the grid lead. The 47-ohm resistor in series with the oscillator grid suppresses any parasitic tendencies that might result from the tapped coil arrangement.

With the values used in the oscillator circuit the tuning range is somewhat more than 300 kc on 80 meters. The tuning slug is used to set the band edges, so no bandset capacitor is needed. For c.w. the v.f.o. will cover from 3500 to 3800 kc, or can be set to cover a similar amount in the phone band.

After the band edges are set to the desired spot slip a narrow shim of stiff cardboard down between the tuning slug and the inside wall of the coil form so that the slug will not be able to move or shift from vibration or handling of the unit.

The output of the v.f.o. may be increased by simply exchanging the regulator tubes, thus raising the voltage on all screens to 150. However, in the interests of stability it is always best to run at the lowest potentials consistent with satisfactory output. The total d.c. input to the v.f.o. as shown is 27 ma, a low figure that results in cool, stable operation.

Nickel-plated crown nuts for the front panel and a coat of gray enamel give a commercial finish that will improve the appearance of the operating position.

Materials for VFO

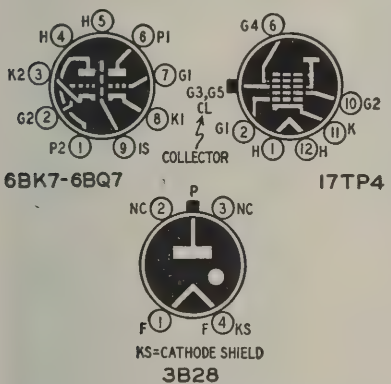
Resistors: 1—47, 1—1,000, 1—47,000, 1—56,000, 1—100,000 ohms, ½ watt; 1—680 ohms, 1—1,500 ohms, 1 watt; 1—10,000 ohms, 2 watts; 1—3,000 ohms, 10 watts, wire-wound, adjustable.
Capacitors: 1—100 μμf, 1—400 μμf, 2—.003 μf, mica; 2—100 μμf, 6—.005 μf, ceramic tubular; 2—10 μf, 450 volt working electrolytic; 1—10 μμf, negative temperature coefficient, ceramic; 1—100 μμf, variable tuning.
Inductors: 1—45 turns No. 28 d.s.c. on XR-50 form (see text); 1—120 turns No. 32 d.s.c. on Millen 74001 form, with 12-turn No. 24 d.s.c. link; 1—RFC, 275 turns No. 34 d.s.c. scramble-wound on 10,000-ohm resistor; 1—RFC, 0.65 mh.
Other components: Transformer, 300-300 volts, 40 ma, 6.3 volts filament; filter choke, 50 ma; 1—d.p.d.t. rotary switch; 1—s.p.s.t. rotary switch. Miscellaneous hookup material, chassis, panel, etc.

—end—

TUBES OF THE MONTH

General Electric Co. has announced the development and release for general sales of a new low-cost miniature television receiver tube designed to reduce snow in fringe-area reception. A somewhat similar tube, the 6BQ7, has been released by RCA.

The new tube, the 6BK7, a 9-pin miniature type, is a duo-triode with a shield between sections and high transconductance. As a cascode amplifier in TV front ends at 216 mc it has a noise factor of only 7 decibels. The tube also has been suggested as a low-noise first-i.f. amplifier in u.h.f. circuits.



Typical operation (two tubes) is: Plate volts, 150; cathode bias resistor, 56 ohms; amplification factor, 40; plate resistance, 4,700 ohms; transconductance, 8,500 μmhos; plate current, 18 ma.

The 6BQ7 characteristics under typical operating conditions are: Plate volts, 150; cathode bias resistor, 220 ohms; amplification factor 35, plate resistance 5,800 ohms; transconductance, 6,000 micromhos; plate current, 9 ma. Noise factor in a television front end at 220 mc is given as 6 db.

A new 17-inch rectangular metal-shell kinescope, the 17TP4, and a high-power gas-filled half-wave rectifier, the 3B28 are other RCA contributions.

The 17-inch television tube features magnetic deflection, low-voltage electrostatic focusing and a frosted filter-glass faceplate to reduce ambient light reflections. The low-voltage focusing element is brought out to a separate pin on the duodecal 6-pin base. Focusing voltage from the receiver B-supply may be either fixed or adjustable.

Operating conditions are: Heater, 6.3 volts at 0.6 amp.; ultor (grids Nos. 3 and 5), 16 kv max.; grid No. 2, 500 volts max.; grid No. 4 (focusing), 0–400 volts; horizontal and vertical deflecting angles, respectively, 66° and 50°; single-field ion-trap magnet.

The 3B28 tube uses a small 4-pin base, a coated filament and is xenon-filled. It will withstand inverse anode peak voltage of 10 kv when delivering 0.25 amp or 5 kv with 0.5 amp anode current. Ambient temperature ratings are —75° to +90° C.

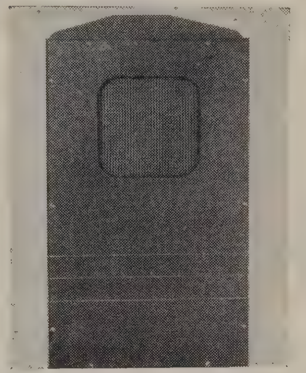
Operating data: Filament, 2.5 volts at 5 amp; anode voltage drop, 14 volts max.; heating time before application of anode voltage, 10 seconds min.

—end—

New Devices

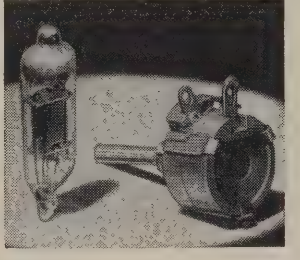
CORNER SPEAKER BAFFLE

Permoflux Corp., 4900 W. Grand Ave., Chicago, Ill., has produced a new corner-type speaker baffle designed to accommodate an 8-inch speaker. The baffle provides a frequency range of from 30 to 12,000 cycles. Finished in maroon leatherette, the unit is 14 inches wide, 24 inches high, and 9½ inches deep.



SUBMINIATURE CONTROLS

Clarostat Mfg. Co., Dover, N. H., has announced the series 48A subminiature variable-resistance controls. Measuring only ⅝ inch in diameter, the body depths are 7/16 and 53/64 inch respectively, for single and dual units. The ⅛-inch shaft, obtainable as flattened or slotted tube or standard rod, extends ½ inch beyond the ¼-inch-long bushing.



The controls are available in tapered or linear resistances. The linear ranges are from 1,000 ohms to 5 megohms, and tapered resistances range from 5,000 ohms to 2.5 megohms.

TV LEAD FEED-THROUGH BUSHING

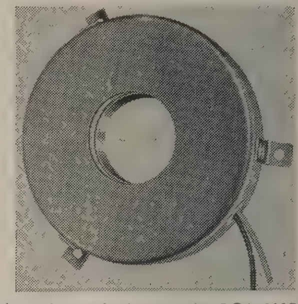
Mosley Electronics, 2125 Lackland Road, Overland, Mo., announces their new *Roof-Thru*, a weatherproof feed-through bushing designed to permit TV lead-ins to be brought in through the roof without allowing moisture to enter. The device consists of a plastic bushing combined with a copper flashing plate. It is readily installed by

lifting a few shingles, drilling a 1-inch hole, inserting the Roof-Thru, and then replacing the shingles. The flashing prevents water from entering the drilled hole and the design of the device prevents leakage through the bushing. The unit makes possible more efficient and less expensive installations by reducing the length of lead-in required.

The Roof-Thru is especially applicable to new-construction work but is almost as easily installed on roofs of old buildings.

TV FOCUS COIL

Standard Transformer Corp., 3592 Elston Ave., Chicago, Ill., has recently added the FC-11 focus coil to their line of TV replacement components.



The unit, equivolent to the RCA 202D2, is made for direct-view picture tubes designed for external magnetic focusing. The FC-11 has a resistance of 470 ohms and carries a maximum current of 140 ma. It is 4¾ inches in diameter, with mounting centers set 120 degrees apart on 2-11/16-inch radii. This and other TV replacement components are described in the Stancor TV Transformer Catalog and Replacement Guide No. 338.

CARBON RESISTORS

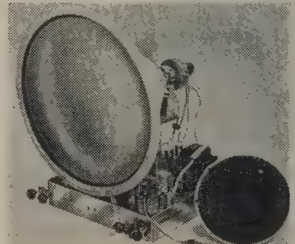
The Phaostron Co., 151 Pasadena Ave., South Pasadena, Cal., has introduced a new deposited-carbon resistor known

as the *Carb-ohm*. It is designed especially for high-frequency applications, particularly where high values of resistance or wattage ratings up to 2 watts are required. The resistors are recommended for use in circuits where matched units are required, and for applications where equipment is subjected to extreme temperatures. They may be used as replacements for wire-wound types in many applications.

The resistors are available either in hermetically sealed glass tubes or clad in a special humidity-impervious casing. Both types of construction provide long-time stability and freedom from variations caused by climatic changes. They are available with the axial leads, as shown, as well as with threaded-stud and tapped-hole terminals. Power dissipation ratings range from ⅓ to 2 watts. Resistances range from 20 ohms to 200 megohms.

WIRED TV CHASSIS

Tech-Master Products Co., 443 Broadway, N. Y., has added three new custom-built models for 24-inch picture tubes to their line of TV chassis. Model 2430 has been designed specifically for all picture tubes requiring from 65 to 70 horizontal degrees deflection (such as 24AP4, 20CP4, 19AP4, etc.) and is supplied with a 5 x 7-inch PM speaker. Model 2431P is similar to model 2430 but contains, in addition, push-pull audio and a phono input jack. 2431P is supplied with a 12-inch PM speaker and universal picture-tube mounting brackets. Model 2431C is basically the same 2430, but with continuous tuner



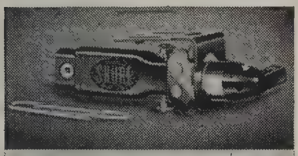
All specifications given on these pages are from manufacturers' data.

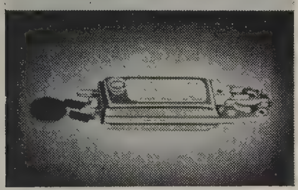
covering TV and FM bands, push-pull audio, and a phono input jack. It is supplied with 12-inch PM-type loudspeaker.

All three models include horizontal a.f.c. and FM sound employing discriminator-type detector. Also featured are noise-saturation circuits; three-stage audio i.f. system; full 4-mc bandwidth; adjacent-channel traps; keyed a.g.c. circuits and universal picture-tube mounting brackets. Special color-converter connections are provided. U.h.f. channels can be accommodated by interchanging tuner strips. All chassis are supplied completely wired, aligned, and tested, with all tubes except picture tubes.

PHONOGRAPH CARTRIDGES

Shure Brothers, Inc., 225 W. Huron St., Chicago, Ill., announces two new replacement phonograph cartridges. The model W22AB-T turnover cartridge is an extended-range vertical-drive unit used as replacements for single-needle



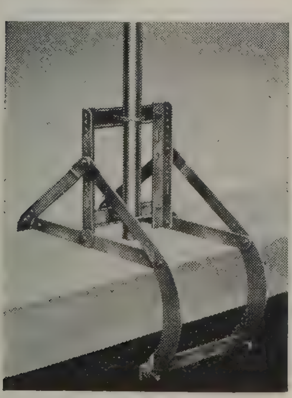


all-purpose cartridges and other types of turnover and dual needle cartridges. It replaces the cartridge and turnover mechanism. Its features are frequency response to 10,000 cycles; tracking with 8 grams; needle pressure, and a standard 1/2-inch bracket mount with elongated holes for quick installation.

Model W42BH, dual-voltage cartridge is a lever-type unit for 78-r.p.m. records. Equipped with a slip-on capacitor-harness for dual-voltage output, 1.5 or 3.75 volts is obtainable in one cartridge. This cartridge replaces old-style 78-r.p.m. cartridges. Special needle guard protects the crystal from breakage.

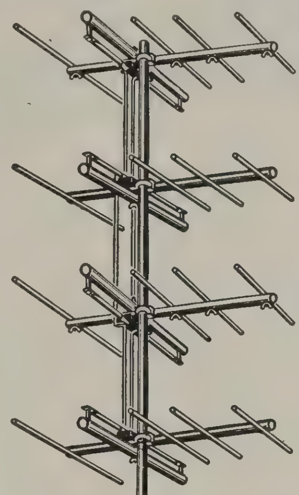
TV MAST MOUNTING BRACKET

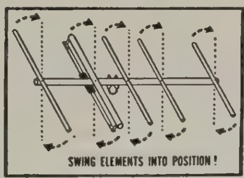
Kenwood Engineering Co., Inc., Kenilworth, N. J., has introduced their model 106 parapet mounting bracket for antenna masts up to 1 1/2 inches in diameter. Made of heavy-gauge galvanized steel, the frame has four claw-like members which clear the coping and extend to the wall. Each claw is tipped with a pointed set-screw which provides positive anchorage to the wall. The unit provides for positive vertical support of the mast regardless of wall contour. It can be quickly installed on walls up to 13 1/2 inches thick. The photo shows the method of mounting and the truss-like construction of the model 106 bracket.



4- AND 5-BAY YAGIS

JFD Manufacturing Co., Inc., 6101 16th Ave., Brooklyn 4, N. Y., is now producing double-stacked four- and five-element Yagi arrays for channels 7–13. The double-stacked arrays include low-

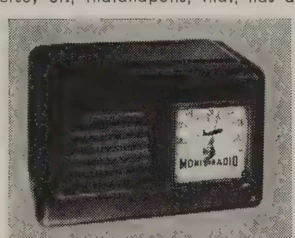




loss jumper-feeder systems which provide a perfect match to 300-ohm impedance. The stacked design boosts the gain up to 20 db over a tuned dipole and also improves directivity in the vertical plane, resulting in clearer pictures, free from interference caused by sources below the antenna plane. Half-wave spacing increases signal pickup and takes advantage of gain increases resulting from in-phase interaction between bays. The *Sky-Ranger* Yagis are constructed of all-aluminum tubing and incorporate high-impedance collector elements.

108-132-MC RECEIVER

Radio Apparatus Corp., 55 N. New Jersey St., Indianapolis, Ind., has de-



veloped a new a.c.-d.c. receiver for monitoring AM aircraft communications in the 108–132-mc band. The receiver, *Monitoradio* model AR-1, receives tower instructions to incoming and outgoing private, commercial, and military aircraft. It is housed in a black plastic cabinet measuring approximately 7 x 6 x 10 inches.

SHIELDED LEADS

United Technical Laboratories, Morristown, N. J. has developed a new line of shielded test leads with proportioned air and polyethylene dielectric for unusually low capacitance and losses, even at u.h.f. The leads have the durability and flexibility required for laboratory and electronic service work. The new type S *Klipzon* shielded leads eliminate stray pickups, feedback, or other undesirable coupling effects. They are supplied in 3-foot lengths with an approximate outside diameter of 9/32-inch, and have a maximum capacitance of only 25 μμf. Black and red *Mini-Prod* connectors are supplied at each lead end for grounding the shield and for circuit or instrument connection, respectively.

—end—

REPORT CALLED "LETDOWN"

Reaction of the service technicians' groups to the RTMA service committee's report—described in the November issue, page 113, has been sharp and generally unfavorable.

First to react was the veteran Federation of Radio Servicemens Associations of Pennsylvania (FRSAP) whose chairman, Dave Krantz, in a letter to Glenn MacDaniel, president of the RTMA, stated:

"It is almost impossible to describe that 'let down feeling' that overcame those in attendance. Its broad phraseology and completely inadequate attempts at solution to some of the many points and problems presented by the service industry to your committee at the meeting in Chicago, exemplify a complete lack of any attempt of the radio and television industry at the manufacturing level to do any more for the service industry than they have done in the past—a big blank zero . . ."

Frank Moch, president of the National Alliance of Television and Electronic Service Associations (NATESA) states in an official bulletin, RTMA answer to NATESA proposals:

"It is nice to know you realize the interdependence of the various segments of the industry. It is, however, unfortunate that despite the apparent awareness of mutual problems, RTMA has taken almost four months to say nothing on the major problems of the industry."

Both letter and bulletin go into the report in some detail, using almost the same words in some cases, especially in regard to the educational proposals. Both believe that the RTMA proposal of technician training through vocational schools—as opposed to the proposal to train today's technicians in the newer aspects of electronic servicing, including color television and u.h.f. would produce results in four or five years instead of meeting the immediate and pressing needs of television.

The National Electronic Technicians and Service Dealers Associations, in its October meeting in New York, stated (as reported on P. 77) that the report was "inadequate and empty of any promise."

A more conciliatory note was struck by the Television Contractors Association of Philadelphia, who in the course of a three-page letter to the chairman of RTMA's Service Committee, says:

"It became clear to us in Chicago, and later in New York, that your Committee is not a policing organization, and that its primary function is to exchange ideas intended to improve conditions in the television industry. The acceptance of these ideas, no matter how desirable, is not mandatory with the individual manufacturers, and we find we have a similar situation in our own organization. We realize that under existing laws the situation could not be otherwise. . . .

"You can depend on us to work along with your Committee, so long as it continues to display this spirit of cooperation. We know you need a little time to erase the problems created over the years, and we shall look for and appreciate each sign of progress. Our only request, at this time, is that you keep us fully informed on what is accomplished."

PENNSYLVANIA PROGRAM

The Federation of Radio Servicemen of Pennsylvania has completed its speaker schedule for 1951 and is now starting to schedule meetings from January to June 1952.

Mr. A. G. Petrasek conducted a series of lectures for RCA Tube Department at all the chapters in September. In October Mr. F. Wendell Tietsworth of the G-E Electronics Department lectured on New Trends in TV Design. The November program featured Mr. Gill, Chief Field Service Engineer of Raytheon TV and Raytheon Tube Divisions, followed by John F. Rider.

The Federation suggested to members that they return to sender or place in waste paper baskets all the parts catalogs that are being received daily, and give full patronage to local distributors.

TELEVISION CONTRACTOR ATTACKS LICENSE MOVE

In a circular opposing the Pennsylvania licensing bills No. 1464 and 1465, Albert M. Haas, president of the Television Contractors Association of Philadelphia, emphasizes the customer's right to choose his own technician.

"As the public begins to learn more and more about television," he says, "the customer begins to exercise his own police powers. There is no greater law than that which permits a consumer to select his technician, contractor or dealer. The fact that a technician is licensed does not gainsay a poor job by the technician and the customer, invoking his prerogatives, refuses to have him back again."

Mr. Haas makes the point that legitimate complaints represent a very small proportion of the servicing jobs, and refers to a recent meeting called to discuss such complaints. He reports:

"During the meeting a few questions developed the fact that many of the alleged complaints were merely inquiries. Most of them were based on dealer or contractor failures which left the consumer at a loss on the unexpired portions of service contracts. Only a small number of these were chargeable to a lack of competence in the technician.

"But, lumping all the complaints together, and assuming they were all received in one month, and comparing them to the 800,000 receivers we had in the city at that time, they amount to the infinitesimal figure of 1/16 of 1%!

ROSE Co's SENSATIONAL FREE GIFT OFFER

TUBES

SPECIAL SAVINGS ON ALL NUMBERS

RMA GUARANTEED—STANDARD BRANDS ONLY

Receiving

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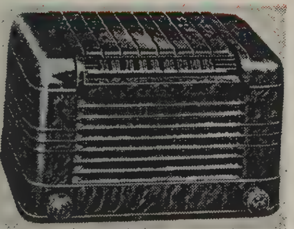
1A5	.69	6L6	1.79
1A7	1.09	6S4	.79
1B3	1.19	6SA7	.69
1R5	.79	6SK7	.79
1X2A	1.19	6SN7	1.09
5U4	.79	6SQ7	.69
5V4	1.39	6T8	1.39
5Y3	.49	6V6	.89
6AB4	.99	7C4	.89
6AC7	1.29	7F8	1.59
6AG5	1.29	12AL5	.89
6AH6	1.89	12AT7	1.29
6AK5	1.89	12AU7	1.19
6AK6	1.19	12AV7	1.29
6AL5	.79	12AX7	1.19
6AQ5	.89	12BH7	1.19
6AT6	.69	12SA7	.79
6AU6	.79	12SK7	.79
6AV6	.69	12SQ7	.69
6BA6	.79	19BG6	2.89
6BC5	.89	19T8	1.39
6BD6	1.09	25BQ6	1.29
6BG6	1.89	35/51	.89
6BH6	.89	35A5	.98
6BJ6	.89	35L6	.89
6BN6	1.39	35W4	.69
6BQ6	1.59	35Y4	.98
6C4	.79	35Z5	.59
6CB6	.89	39/44	.49
6CD6	2.79	50A5	1.19
6H6	.79	50B5	.98
6J6	1.19	50L6	.75
6K6	.69		

Transmitting

0B2	$1.69
0C3/VR105	1.29
0D3/VR150	1.19
2X2	.79
3EP1	5.39
3HP7	3.49
5FP14	16.99
7BP7	7.89
7CP1	12.49
211	.79
304TH	12.49
GL471A	2.75
12A6	.69
717A	1.99
803	2.99
805	3.49
807	1.79
809	1.79
813	7.49
872A	2.39
885	1.29
905	2.29
954	.29
1616	1.19
1624	1.49
1629	.35
2051	1.19
7193	.29
8020	1.25
9006	.29

SPECIAL CHRISTMAS SALE
5-Tube, AC/DC, Superhet
RADIOS



Brand New Famous make, table model radio with illuminated slide-rule dial, highly polished walnut plastic cabinet with streamlined grille, delivers greater wattage output for finer, undistorted tone and with automatic volume control to maintain uniform volume, prevents blasting on strong signals and reduces fading.

Licensed by RCA!

Look at these Specs!

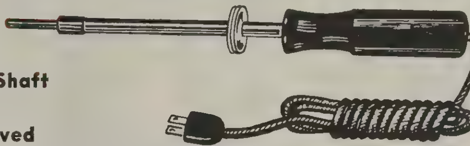
- 5 Tubes, incl. rectifier
- AC/DC Superheterodyne circuit
- Alnico V Speaker for true tone
- 540 to 1650 KC (560 to 182 meters)
- 6 Tuned Circuits
- Built-in loop antenna
- 10¼" x 6¼" x 5½"
- 7 lbs., 3 oz., shipping weight

lots of 3 complete Dealer Net, $13.95

$15.95 ea.

FREE!

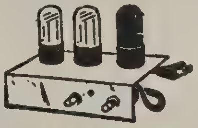
This Superior *Electric* SOLDERING IRON. What every serviceman needs! Yours absolutely FREE!



- ★ Nickel Chrome Wire Heating Element
- ★ Handsomely Plated Shaft
- ★ Replaceable Tips
- ★ U.L. & C.S.A. Approved

For a limited time, the ROSE Co. is offering, **absolutely FREE**, this wonderful new soldering iron to its customers. With each order of $25. you get FREE this 75 Watt electric soldering iron. A $50. order brings you a 100 Watt Soldering Iron or two (2) 75 Watt Irons. A 75W. iron for each $25. order. Be sure to mention which iron you want with your order. Act quickly—order Now! **GET THIS SUPERIOR ELECTRIC SOLDERING IRON NOW . . . ABSOLUTELY FREE.** We're sorry that this offer cannot include TV chassis, Picture Tubes, or complete radios.

Terrific Value!



3-TUBE PHONO AMPLIFIER

For 3-speed players

For all type records, 2½ Watt output. Completely wired with full range tone and volume controls, plus switch. Special $2.95 ea. (less tubes)

SET OF TUBES FOR AMPLIFIER (above)	$2.95
Output, 50L6	.49
Pickup, single speed	1.89
Pickup, 3-speed	4.95
Motor, 78 R.P.M. & Turntable	2.89
Motor, 3-speed & Turntable	4.95

TV PICTURE TUBES

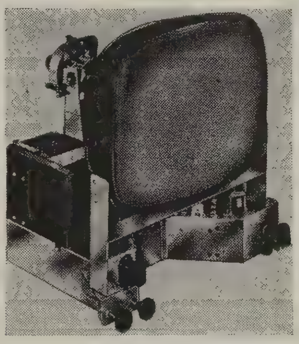
Full Year's Guarantee Not Pro-Rata— Black Face—Brand New—Standard Brands Sealed Cartons

10BP4	$24.95	16GP4	$31.95	19AP4A	$37.95
12LP4	24.95	16HP4	33.95	20CP4	37.95
14BP4	24.95	17BP4	29.95	24AP4	69.95

The Great 630 Super Chassis

Bargain Priced for Terrific Savings!

30-Tubes—RCA lic.—For 16" to 24" Picture Tubes



- High efficiency high voltage circuit
- Keyed AGC
- Automatic brightness control
- Special extra-high gain standard coil tuner
- Directly adaptable for color
- 12" Quality speaker
- Factory wired, aligned & tested
- Complete, ready to play
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Complete $144.50 (less CRT)

Special: With Dumont Inputuner, FM Radio and RCA 12" Speaker only $154.50 (less CRT)

630DX Chassis, 3-times normal reception of regular chassis. Needs no complicated antenna or booster. $159.50 **Reduced to** less-CRT

FREE OFFER: Schematic diagram FREE with any chassis ordered!

ROSE SLASHES PRICES AGAIN!

SPEAKERS

All Alnico V—Every one a Buy!

4" P.M.	$1.59 ea.
5" P.M.	1.69 "
6" P.M.	1.89 "
12" P.M.	5.95 "
4"x6" P.M.	1.79 "
6" 62 ohm with output	3.75 "
4"x6" 1500 ohm with output	3.49 "

DEDUCT 5% from price of any Speaker in lots of 10 or more. May be assorted. ORDER NOW before cobalt freeze advances prices!

Rose Saves You Plenty!

ELECTROLYTIC CONDENSERS

All Guaranteed Fresh Stock

	ea.	lots of 10	lots of100
20x20—150 V.	$0.39	$3.70	$34.95
40x40—150 V.	.45	4.30	39.95
50x30—150 V.	.45	4.30	39.95
50x50—150 V.	.49	4.50	41.95
40x40x20—150 V.	.69	6.70	59.95
50x30x20—150 V.	.69	6.70	59.95
50x50—150 V. (200-25 V.)	.79	7.70	69.95
25—25 V.	.19	1.50	13.50
25—50 V.	.19	1.50	13.50
20—250 V.	.29	2.59	23.95
8—450 V.	.39	3.69	32.50
10—450 V.	.39	3.69	32.50
16—450 V.	.59	5.69	49.50

Order Now! Save Now!

May be Asst. for 100 Lot Price!

Special!

GENUINE MOLDED CONDENSERS

Fresh Stock—All Mineral Oil Filled—100° Centigrade—Meets Jan. C91 Tests. **ALL 600 VOLTS**

Cap.	per 10	per 100
.001	$ .79	$ 6.90
.002	.79	6.90
.005	.79	6.90
.01	.89	7.90
.02	.99	8.90
.05	1.09	9.90
.1	1.25	11.50

May be Asst. for 100 Lot Price!

AC LINE CORDS

Special Savings

6 ft. . . . 21¢ ea.

Now! 10 for $1.89

VOLUME CONTROLS

	ea.
1 Meg. & Switch	42¢
½ Meg. & Switch	42¢
1 Meg. less switch	23¢
½ Meg. less switch	23¢

SPECIAL! DEDUCT 5¢ from the price of each in lots of 10 or more!

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NOW AVAILABLE . . . FREE! Write for new catalog including complete listings of tubes, parts, accessories for radio and TV and special test equipment catalog for instruments and kits!

MINIMUM ORDER: $5.00. 25% deposit with order, balance C.O.D. Include postage with order. All merchandise subject to prior sale. F.O.B. New York, N. Y.

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Is THIS why we must have technicians licensed?

"Just a few months ago a national magazine told us a story of some scandals in the medical profession. It was pointed out that there were a great number of 'quacks' in the profession . . . but . . . it was also pointed out that the number of quacks in relation to competent physicians was very small. . . . All the vaunted power of our States cannot keep them out!

"I have heard and listened carefully," said Mr. Haas further on in his letter, "to the arguments advanced by the supporters of these laws. The words are gilt-edged and, all put together, they promise Utopia without undue effort on the part of anyone. That they have been, apparently, accepted by technicians in general seems only to prove that they have an unusually high degree of gullibility.

"What is better than licensing? A real appreciation of our very important position in the radio-television industry, and constant efforts to improve our status in the eyes of the consumer upon whom we all depend for our livelihood. The continuance of our efforts to educate the public as to the nature of his television receiver and just what he can expect from it."

EMBLEM OF NATESA

NATIONAL ALLIANCE OF TELEVISION & ELECTRONIC SERVICE ASSOCIATIONS
NATESA

This emblem of the National Alliance of Television and Electronic Service Associations is available to members.

PITTSBURGH ACTIVITY

The members of the Radio and Television Servicemen's Association of Pittsburgh heard a full report from their president, George Sharpe, on the State Federation meeting which he attended as a delegate. He brought back an especially complete account of the 50-point program presented by the Federation to Philadelphia's Joint Electronic Radio Committee on Service, and also a detailed report on the revised State licensing bill. Acceptance of the 50 points as an association goal and of the revised licensing bill was approved practically unanimously.

SCHOOL OPENS AGAIN

Courses at the regular radio and TV school of the Blair County (Pennsylvania) Association of Radio Service Engineers were resumed after a summer vacation, with Mr. Brubaker as instructor.

Several manufacturers meetings have been conducted in Altoona, through the cooperation of the Federation of Radio Servicemen of Pennsylvania and distributors. The open meetings conducted by RCA and Taco were very well attended.

LACKAWANNA INSTALLS

The Lackawanna, Pennsylvania, Radio Service Technicians Association installed its new officers at a recent meeting.

The officers are: president, James Jerome, Olyphant; vice president, Raymond Rogers, Peckville; secretary, Howard Greene, Scranton; treasurer, Henry Govan, Olyphant; directors, Leon Helk, Carbondale; Merrill Greene, Scranton, and Fay Maynard, Scranton. Merrill Greene, Scranton, is the retiring president. The officers were installed by Mr. Helk, a past president.

The following committee chairmen were named: Public relations, Mr. Helk; complaint, Merrill Greene; membership, Joseph Kuzmac, Scranton; ways and means, Mr. Maynard; technical, Karl Mead, Scranton. William Slavinskas, Scranton, was made chairman of arrangements for the State Federation meeting at which the local association acts as host.

LECTURE AT HARRISBURG

Mid-State Radio Servicemen's Association had a very interesting lecture meeting, sponsored by the local distributor, D & H of Harrisburg, Pa. The principal speaker, Mr. A. G. (Slim) Petrasek of RCA, who spoke on servicing problems, demonstrated his lecture with a live chassis and RCA's latest test equipment. Several new members were taken into the Association.

Members of the MSRSA have been furnished, at a small charge, with the keystone emblem stamp intended for use on contracts or repair bills. This stamp informs the customers that they are dealing with an Association member.

ESFETA'S FALL MEETING

The quarterly meeting of the Empire State Federation of Electronic Technicians Associations (ESFETA) was held in New York City at Toots Shor's on October 7th under the chairmanship of Wayne Shaw of Ithaca. All chapters were present. The delegates spent a great deal of time discussing educational programs, membership drives, the RTMA report and the dues structure to be paid NETSDA. The Empire State Federation will promote programs with the intention of helping the local chapters build larger memberships.

NETSDA MEETS IN N. Y.

More than 50 delegates and visitors were present at the October 7 meeting of the National Electronic Technicians and Service Dealers Associations in New York City. In addition to the chapter members, there were delegations from Westchester, Rochester, and Buffalo, New York, and from Fall River and Boston, Mass.

Dues per capita were discussed and referred to the finance committee headed by Vance Beachley, Treasurer.

The RTMA Service Committee's report was presented at completion of the reports of the representatives present at this meeting. NETSDA went on rec-

ord rejecting it as inadequate and empty of any promise to meet the present day servicing problems.

A committee was appointed to focus public attention on the New York City and Pennsylvania licensing bills and supply information to all other servicing associations and persons interested.

A nominating committee was appointed to select a list of candidates for elective offices during the coming year.

The body approved the following resolution. "NETSDA representatives will not attend any future meetings called by the industry unless duly authorized representatives only of National or State groups are in attendance."

TV GYP FINED $1,000

Television Associates, Los Angeles, California, was ordered to pay a $1,000 fine after having pleaded guilty to charges of petty theft. A former president of the corporation was also sentenced to 50 days in the county jail. Judge Paul McIver was more sympathetic to the present president, Mrs. Patricia Smith, whom, he stated, "went almost overnight from clerk to president and who appears to be the victim of others designing to run for cover." She was put on probation for two years, with the proviso that she serve the first five weekends in the county jail, and that she "cooperate with those investigating the TV racket without reservation in order to bring those responsible for this conspiracy to justice."

Television Associates had been accused of a number of offenses ranging from overcharges to assault and battery, including—believe it or not—twisting a customer's arm. According to the customer, the latter offense occurred when an employee of the company, allegedly acting under the orders of the president of the company, demanded her warranty contract when returning her repaired set. On her refusal, she charged that he started to take away the set, and the arm-twisting occurred when she (unsuccessfully) attempted to prevent the delivery man from taking away the repaired receiver in lieu of the contract.

DROP LICENSE PROPOSALS

Proposals to license TV technicians in Milwaukee were dropped at a public hearing before the licensing committee of the Milwaukee Common Council, according to a recent story in *Retailing Daily*.

Chief objections to the proposed ordinance centered about its provisions for an annual license fee ranging from $100 to $500, the amount of experience required before a technician could be licensed, the minimum size requirement for a television repair shop, and the quantity of test equipment each service organization would be compelled to have.

An even more telling blow against the proposed bill was delivered by Richard Jordan, manager of the local Better Business Bureau. His testimony indicated that the efforts of the local television service organizations to police the industry themselves had been highly successful. Complaints last winter, he stated, had totalled between 300 and 400 a month.

The present total number has dropped to only slightly more than 100 per month, which he considered encouraging "for an industry which is still growing and which still has some bugs in it."

BBB REPORTS COMPLAINTS ARE DOWN IN COLUMBUS

The September meeting of the Associated Radio-Television Service Dealers of Columbus, Ohio, which was also the year's third quarterly Associate Jobber Meeting, featured an address by Mr. Gordon Kilmer of the Better Business Bureau. Mr. Kilmer reported that the TV complaints at the Better Business Bureau had dropped off considerably during the past year—a trend exactly opposite to that in many other large cities.

Two of the factors which were cited as contributing to this desirable trend were: the better understanding by the layman of the many problems of TV, and the efforts of ARTSD to "Keep Columbus Clean."

L.A. PREPARES ORDINANCE

The city attorney and the Building and Safety Department of the city of Los Angeles were instructed to draw up an ordinance, "which in their opinion will give due process by law to stop this gypping in the TV repair business."

The action, which took place late in September, followed one by the Los Angeles County supervisors in ordering preparation of a licensing ordinance for TV repair shops in unincorporated areas in Los Angeles County. Unlike the city license, which was apparently to be under the Building and Safety Department, the county plan proposed that the licensing be under the control of the county sheriff, whose representatives would inspect repair shops regularly "for recovery of lost or stolen sets or parts, and to assist in eliminating fraudulent practices."

According to Administrative Officer Wayne Allen, licensing of TV repair shops "is necessary for the same reason as is licensing of auto repair shops, auto wreckers, auctioneers and others he listed.

The type of licensing proposed for the city is not as clearly foreshadowed, but it is likely that it will follow somewhat similar lines to those proposed in the unincorporated areas.

VANCOUVER *BULLETIN* REAPPEARS

After a lapse of some months the official organ of the Radio Electronic Technicians Associations of Vancouver and British Columbia has resumed publication with its September number. Much of the news concerns a recent meeting of the Vancouver chapter, at which delegate Jim Baird reported on the meeting of the national association, The Radio Electronic Technicians of Canada (RETA), in Regina, Saskatchewan. A meeting of the Victoria chapter at which a "free tube testing" envelope stuffer sent out by a large advertiser was discussed and strongly deprecated; also, a report that many qualified electronic technicians have left for other fields. The editor feels that the explanation for the desertions from the ranks of the technicians is that top wage in Victoria is only $1.40 per hour.

PATERSON, NEW JERSEY, ACTIVE

The Radio Servicemen of New Jersey, Inc. have announced their affiliation with the National Alliance of Television & Electronic Service Associations (NATESA).

The association, which is located in Paterson, has made arrangements with the Allen B. Du Mont Laboratories for a series of lectures on u.h.f. and color, beginning in November. H. B. Rhodes, the president of RSNJ, indicated that other service organizations in the vicinity would be invited to these meetings.

RSNJ is also working on a plan for a legal and foolproof escrow system, which will probably take the form of a trust fund to which the members will subscribe—with the object of protecting service contract holders in the event that any one of the member service organizations should, through financial reverses, encounter difficulties in carrying out its contract obligations.

SHORTAGE OF TECHNICIANS IMMINENT?

Shortage of trained service technicians may become television's main problem in the near future, according to Paul V. Forte of the Philadelphia Television Contractors Association.

Service contractors were compelled to retrench drastically during last summer's slow period, Mr. Forte pointed out. Every technician who was not absolutely necessary was let go. These men got jobs in the expanding electronic defense production, usually at higher wage rates. Therefore they have been lost to the service industry.

The industry itself has failed miserably to train service technicians, Mr. Forte said, and no present or proposed plan will provide sufficient numbers of trained men in the next few years.

—end—

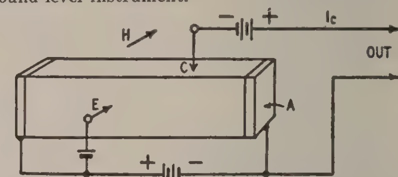
Reserve Your Television Issue NOW!

Our Special Annual Television Issue comes out next month. This will be the biggest issue we have ever printed—160 full pages of information and data on receivers, antennas, boosters, u.h.f., conversions, servicing, and other articles of the TV technician, as well as our full complement of audio and radio articles and departments.

TRANSISTOR MICROPHONE

Patent No. 2,553,491
William Shockley, Madison, N. J.
(Assigned to Bell Telephone Laboratories, Inc.)

This inventor, who has done much work with transistors, has a new application for semiconductors. He uses a germanium filament connected so that its output varies with vibration. By attaching a diaphragm it becomes a microphone or sound-level instrument.

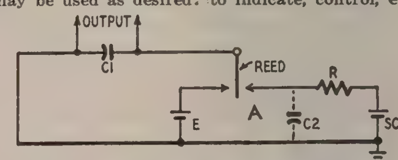


The figure shows an N-type germanium filament or elongated body of square cross-section connected as a transistor. The emitter E and collector C are biased by batteries. Holes emitted by E tend to flow through the filament to A which is negative. Their motion is also controlled by a magnetic field H transverse to the filament. (The body is placed between the poles of a strong magnet.) Therefore the holes also have an upward component. At some critical value of H, the holes move directly toward C and the output current is maximum. The output drops as H is increased.

STANDARD CELL CIRCUIT

Patent No. 2,565,892
Leonard Stanton, Philadelphia, Pa.
(Assigned to Minneapolis-Honeywell Regulator Co.)

This invention decreases the peak load of a standard cell. A simplified circuit is shown. A vibrator reed switches between cell SC and a source of variable voltage E. When the voltages are unequal, a.c. output exists across C1. Output phase depends upon whether E is larger or smaller than the constant potential SC. The output a.c. may be used as desired: to indicate, control, etc.



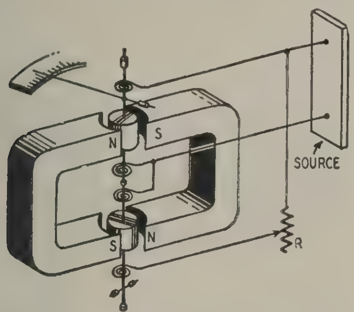
It is important to limit the peak current flowing from SC. This peak occurs at the instant the reed contacts terminal A. Thereafter, the flow decays exponentially as C1 charges. This inventor uses a clever yet simple method. He merely adds a very large capacitor C2. With this connection, peak current is taken from C2, not the cell. SC supplies a more constant current during the entire vibrator cycle.

INSTRUMENT DAMPING

Patent No. 2,560,257
Frederick R. Sias, Marblehead, Mass.
(Assigned to General Electric Co.)

An electrical meter may indicate incorrectly if it is moved about while a reading is taken. For example, the meter may be aboard a moving airplane or it may be an exposure meter carried in the hand. This new design eliminates error due to this cause.

The new instrument consists of two similar meters placed back-to-back. They have a common axis of rotation and are connected in parallel across the source being measured. When current



is applied, the front meter deflects clockwise as usual. The rear meter will deflect counter-clockwise. Both deflections are "up-scale," of course.

Now if an external acceleration is imparted to this dual instrument, each armature tends to move in the *same* direction, for example clockwise. Each coil generates an emf when it cuts through its magnetic field. Because of the back-to-back arrangement, the induced voltages are *additive* so current flows through the two coils and R in series. The motion is damped out by being converted to electric power. R controls the damping.

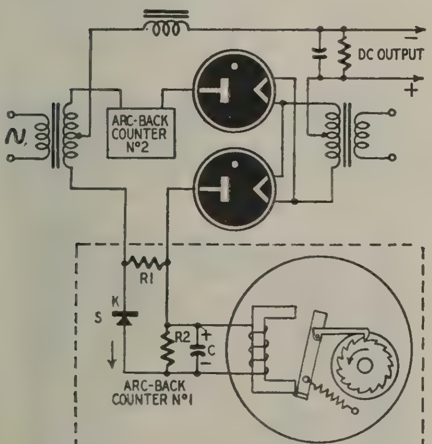
During normal measurement of current, the two coils move in *opposite* directions. Therefore the induced voltages oppose and there is no damping of this component of the motion.

ARC-BACK COUNTER

Patent No. 2,557,848
George L. Usselman, Port Jefferson, N. Y.
(Assigned to Radio Corp. of America)

This counter records the number of arc-backs which occur in a high voltage rectifier system. During a flash-over an instantaneous high current flows from anode to cathode of a rectifier tube. If the flashes occur repeatedly or frequently, the rectifier tube should be replaced to prevent damage to the other components.

The counter includes a selenium rectifier S,



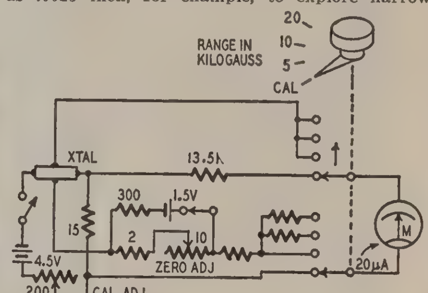
resistors R1 and R2, and a capacitor C. There is also a relay mechanism as shown within the circle. Normal rectifier current flows through R1 from the rectifier plate. Should an arc-back occur, current will flow through S and R2, charging C with polarity as indicated. The relay coil is energized and its armature is attracted. The ratchet wheel is moved forward one tooth by each flash-over. After an arc-back, C discharges through R2 and the counter is ready for the next breakdown.

Magnetic Field Strength Meter

Patent No. 2,562,120
Gerald L. Pearson, Millington, N. J.
(Assigned to Bell Telephone Laboratories, Inc.)

This sensitive instrument is based on the Hall effect. It needs no amplifiers or high-voltage supplies. A flat probe is utilized to explore a magnetic field. A calibrated meter indicates the field strength in kilogauss.

The probe consists of germanium deposited on a flat quartz plate. Such a probe may be as thin as .0025 inch, for example, to explore narrow gaps. The probe is held transverse to the field. The Hall effect requires a d.c. flow through the germanium in a direction at right angles to the field. Under this condition a voltage is generated which is proportional to the current and the field and is at right angles to each.



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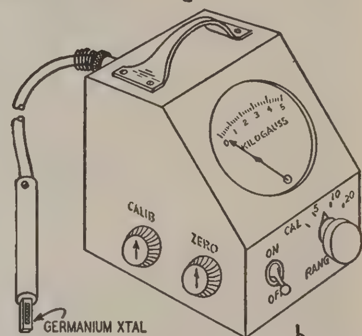


b

The crystal current is supplied from a 4.5-volt battery in series with a calibrating resistor. See *a* in the figure. The current is adjusted to the desired value by throwing the range switch to CAL and noting the meter M. To make a measurement, the switch is thrown to one of the three kilogauss ranges. The zero adjustment is set for null reading when the field is zero. Now M is a voltmeter in series with a multiplier resistor, and it indicates the Hall voltage output.

Probe polarity must be observed. If it is incorrectly inserted into a gap (that is, facing the wrong magnetic pole) M will read backward.

This instrument was described in the Review of Scientific Instruments, April 1948. A portable model is shown at *b* in the figure.

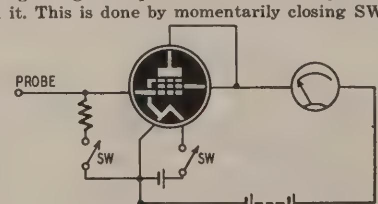
STATIC DETECTOR

Patent No. 2,556,458
Raymond C. Webster, Kansas City, Mo.
(Assigned to W. E. Anderson, Inc.)

A vacuum tube makes a sensitive detector of negative static charges. A pentode detector is shown in the figure. When the probe is brought near a charged body, part of the charge is transferred to the grid by induction. There is a proportionate drop in plate current as will be indicated by the microammeter.

The instrument is not so effective for measuring positive charges. A positive grid attracts electrons which are trapped (since SW is left open during a measurement). In a short time the positive charge on the grid is neutralized.

Before testing for a charge, the grid should be brought to ground potential to remove any charges on it. This is done by momentarily closing SW.



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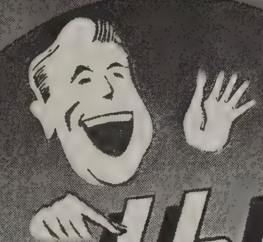
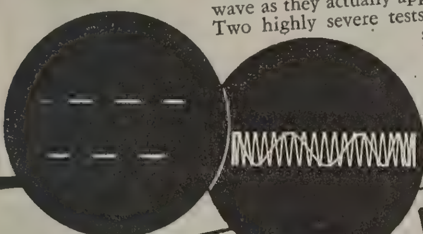
Features OF THE NEW 1952 Heathkits



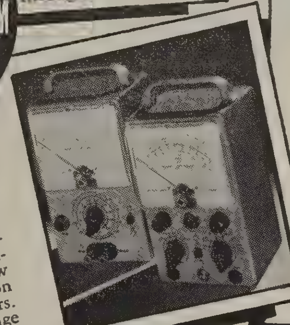
PROOF OF THE NEW O-7 OSCILLOSCOPE'S OUTSTANDING PERFORMANCE

Below are actual, unretouched photographs showing the outstanding frequency response characteristics of the NEW 1952 HEATHKIT OSCILLOSCOPE MODEL O-7. To the left is a 10 KC square wave — to the right a 4 MC sine wave as they actually appear on the screen. Two highly severe tests to make on any scope (only the best of scopes will show traces like these) — and the O-7 really comes through.



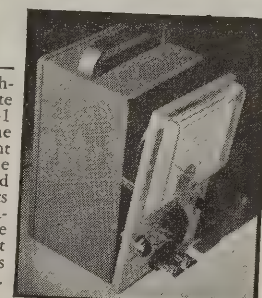
COMPANION VACUUM TUBE VOLTMETERS

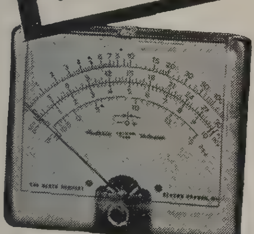
Here are the two NEW 1952 VACUUM TUBE VOLTMETER COMPANION PIECES. Matched instruments of new design to open up the whole field of DC, AC, and resistance measurements for you. The new greatly reduced size combines style, beauty, and compactness — The V-5 and AV-1 have the new panel and cabinet construction as shown on the right. A tremendous pair of voltmeters. Small in size but virtual giants in the range of measurements they make.



NEW STYLE AND BEAUTY

Style that's modern, yet functional — that's the trend of today — and Heathkits are right up to the minute. Note the cut showing the new V-5 and AV-1 cabinet and panel construction. The front panel and rear cover slide right over the recessed flange of the case thereby eliminating sharp edges and pointed corners. The voltmeter kits aren't "shelf" or "mounted" instruments — they're moved about on the bench a lot and thus the new compact size and specially designed cabinets — Another 1952 Heathkit feature.

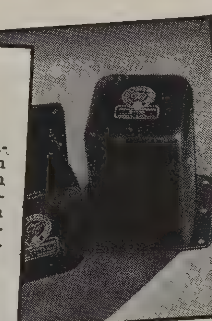




A STATEMENT FROM SIMPSON ELECTRIC CO.

In choosing Simpson Meters for their Heathkit VTVM, the Heath Co. has set a new high standard of kit meter quality. The same high quality of material, workmanship and design that has given Simpson the reputation for building "Instruments That Stay Accurate" is found in the Heathkit Meter Movement.

SIGNED
SIMPSON ELECTRIC CO.



A STATEMENT FROM CHICAGO TRANSFORMER

It is indeed gratifying to note the outstanding sales records you are building with you Heathkits.

This sales success is readily understandable, since we are cognizant of the high quality standards you have established for your component suppliers.

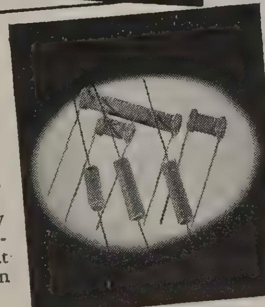
We at Chicago Transformer are proud that our product has contributed to the recognized quality and increasing popularity of Heathkits.

CHICAGO TRANSFORMER DIVISION
Essex Wire Corporation

L. S. RACINE
Vice-President and Sales Manager

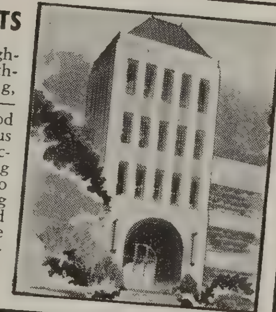
HEATHKIT PRECISION RESISTORS

Where exact resistance values are required for instrument accuracy, the Heath Co. has spared no effort in supplying the finest resistors available. Precision resistors as manufactured by Continental Carbon Inc., and Wilcor Corp., meet the rigorous JAN (Joint Army-Navy) specifications and are small in size, extremely non-inductive, highly stable, have a low temperature coefficient, and can be held to great accuracy. You'll find quality components in Heathkits.



COLLEGES USE HEATHKITS

Colleges and Universities throughout the country are using Heathkits in their electrical engineering, radio, and physics laboratories — Heathkits are the answer to good test equipment at low cost, plus being rugged, dependable, and accurate. Trade schools are having their students build Heathkits to obtain a first hand working knowledge of test equipment and to get the practical experience gained by construction. Heathkits fill school needs.



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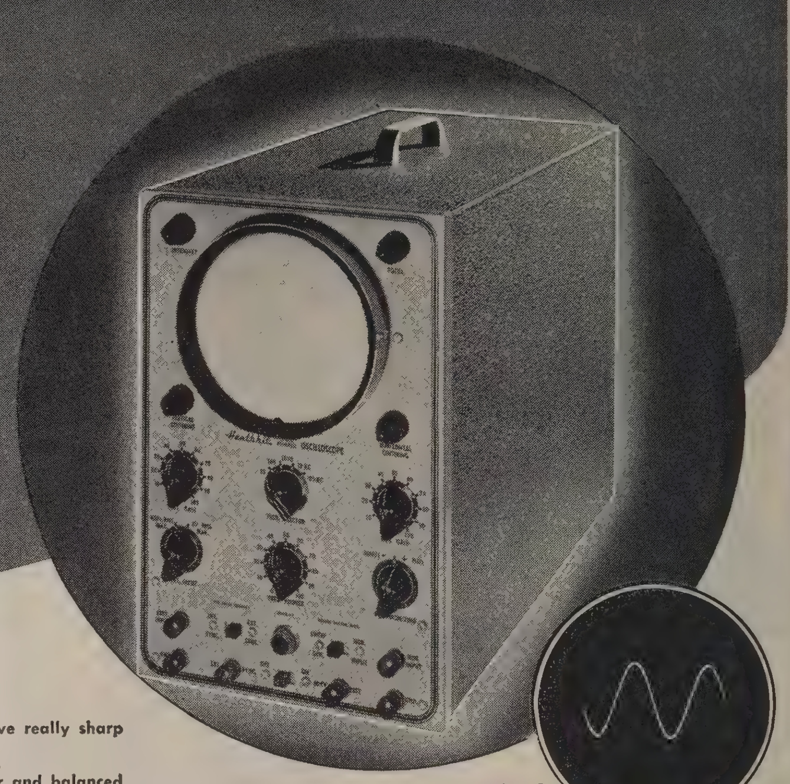


Features

- New "spot shape" control for spot adjustment — to give really sharp focusing.
- A total of ten tubes including CR tube and five miniatures.
- Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.
- Greatly reduced retrace time.
- Step attenuated — frequency compensated — cathode follower vertical input.
- Low impedance vertical gain control for minimum distortion.
- New mounting of phase splitter and deflection amplifier tubes near CR tube base.
- Greatly simplified wiring layout.
- Increased frequency response — useful to 5 Mc.
- Tremendous sensitivity .03V RMS per inch Vertical — .6V RMS per inch Horizontal.
- Dual control in vernier sweep frequency circuit — smoother acting.
- Positive or negative peak internal synchronization.

The performance of the NEW, IMPROVED, HEATHKIT 5" OSCILLOSCOPE KIT is truly amazing. The O-7 not only compares favorably with equipment costing 4 and 5 times as much, but in many cases literally surpasses the really expensive equipment. The new, and carefully engineered circuit incorporates the best in electronic design — and a multitude of excellent features all contribute to the outstanding performance of the new scope.

The VERTICAL CHANNEL has a step attenuated, frequency compensated vertical input which feeds a cathode follower stage — this accomplishes improved frequency response, presents a high impedance input, and places the vertical gain control in a low impedance circuit for minimum distortion. Following the cathode follower stage is a twin triode — cascaded amplifiers to contribute to the scope's extremely high sensitivity. Next comes a phase splitter stage which properly drives the push-pull, hi-gain, deflection amplifiers (whose plates are directly coupled to the vertical deflection plates). This fine tube lineup and circuitry give a sensitivity of .03V per inch RMS vertical and useful frequency response to 5 Mc.

The HORIZONTAL CHANNEL consists of a triode phase splitter with a dual potentiometer (horizontal gain control) in its plate and cathode circuits for smooth, proper driving of the push-pull horizontal deflection amplifiers. As in the vertical channel, horizontal deflection amplifier plates are direct coupled to the CR tube horizontal deflection plates (for improved frequency response).

The WIDE-RANGE SWEEP GENERATOR circuit incorporates a twin triode multivibrator stage for producing a good saw-tooth sweep frequency (with faster retrace time). Has both coarse and vernier sweep frequency controls.

And the scope has internal synchronization which operates on either positive or negative peaks of the input signal — both high and low voltage rectifiers — Z axis modulation (intensity modulation) — new spot shape (astigmatism) control for spot adjustment — provisions for external synchronization — vertical centering and horizontal centering controls, wide range focus control — and an intensity control for giving plenty of trace brilliance.

The Model O-7 EVEN HAS GREAT NEW MECHANICAL FEATURES — A special extra-wide CR tube mounting bracket is provided so that the vertical cascade amplifier, vertical phase splitter, vertical deflection amplifier, and horizontal deflection amplifier can mount near the base of the CR tube. This permits close connection between the above stages and to the deflection plates; distributed wiring capacity is greatly reduced, thereby affording increased high frequency response.

The power transformer is specially designed so as to keep its electrostatic and electromagnetic fields to a minimum — also has an internal shield with external ground lead.

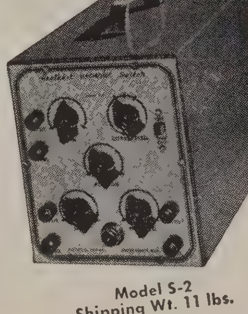
You'll like the complete instructions showing all details for easily building the kit — includes pictorials, step-by-step construction procedure, numerous sketches, schematic, circuit description. All necessary components included — transformer, cabinet, all tubes (including CR tube), completely punched and formed chassis—nothing else to buy.

NEW INEXPENSIVE *Heathkit* ELECTRONIC SWITCH KIT

The companion piece to a scope — Feed two different signals into the switch, connect its output to a scope, and you can observe both signals — each as an individual trace. Gain of each input is easily set (gain A and gain B controls), the switching frequency is simple to adjust (coarse and fine frequency controls) and the traces can be superimposed for comparison or separated for individual study (position control).

Use the switch to see distortion, phase shift, clipping due to improper bias, both the input and output traces of an amplifier — as a square wave generator over limited range.

The kit is complete; all tubes, switches, cabinet, power transformer and all other parts, plus a clear detailed construction manual.



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THE *New* 1952 *Heathkit* VTVM KIT

MODEL V-5
SHIPPING WT. 5 LBS.

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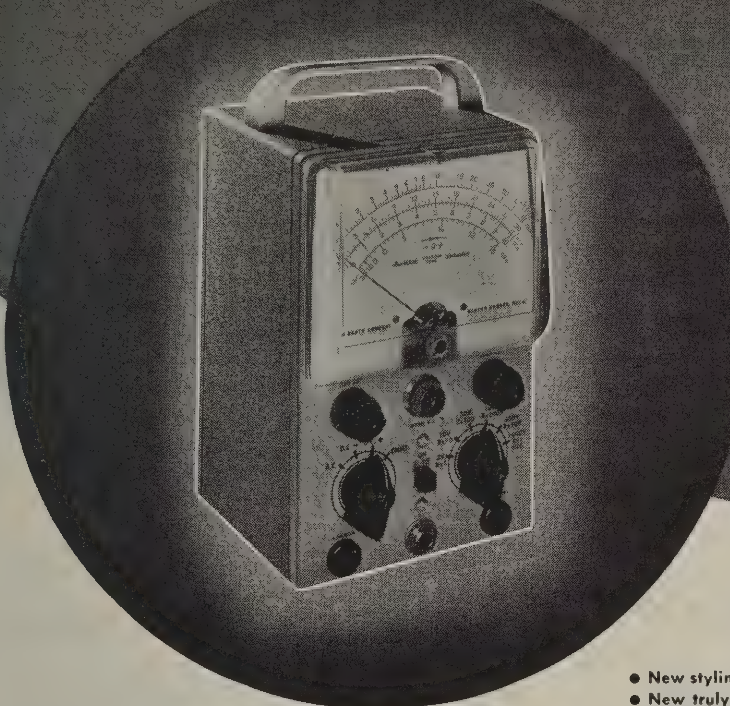


A real beauty — you'll have only highest praise for this NEW MODEL VACUUM TUBE VOLTMETER. Truly a beautiful little instrument — and it's more compact than any of our previous models. Note the new rounded edges on the front panel and rear cover. The size is greatly reduced to occupy a minimum of space on your workbench — yet the meter remains the same large size with plainly marked scales.

A set of specially designed control mounting brackets permit calibration to be performed with greatest ease — also makes for ease in wiring. New battery mounting clamp holds ohms battery tightly into place, and base spring clip insures a good connection to the ohms string of resistors.

The circuitry employs two vacuum tubes — A duo diode operating when AC voltage measurements are taken, and a twin triode in the circuit at all times. The cathode balancing circuit of the twin triode assures sensitive measurements, and yet offers complete protection to the meter movement. Makes the meter burn-out proof in a properly constructed instrument.

Quality components are used throughout —1% precision resistors in the multiplier circuit—conservatively rated power transformer—Simpson meter movement — excellent positive detent, smooth acting switches — sturdy cabinet, etc.

And you can make a tremendous range of measurements — ½V to 1000V AC, ½V to 1000V DC, .1 to over 1 billion ohms, and DB. Has mid-scale zero level marking for quick FM alignment. DB scale in red for easy identification — all other scales a sharp, crisp black for for easy reading.

A four position selector switch allows operator to rapidly set the instrument for type or reading desired—positions include ACV, DC+V, DC—V, and Ohms. DC— position allows negative voltage to be rapidly taken. Zero adjust and ohms adjust controls are conveniently located on front panel.

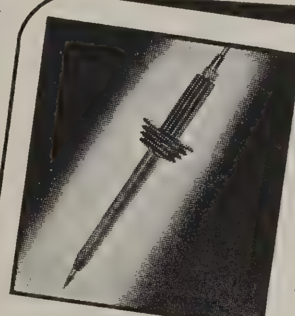
Enjoy the numerous advantages of using a VTVM. Its high input impedance doesn't "load" circuits under test — therefore, assures more accurate and dependable readings in high impedance circuits such as resistance coupled amplifiers, AVC circuits, etc. Note the 30,000 VDC probe kit and the RF probe kit — available at low extra cost and specially designed for use with this instrument. With these two probes, you can make DC voltage measurements up to 30,000V, or make RF measurements — added usefulness to an already highly useful instrument.

The instruction manual is absolutely complete — contains a host of figures, pictorials, schematic, detailed step-by-step instructions, and circuit description. These clear, detailed instructions make assembly a cinch.

And every part is included — meter, all controls, pilot light, switches, test leads, cabinet, instruction manual, etc.

Features

- New styling, — formed case for beauty.
- New truly compact size. Cabinet 4⅛" deep by 4-11/16" wide by 7⅜" high.
- Quality 200 microamp meter.
- New ohms battery holding clamp and spring clip — assurance of good electrical contact.
- Highest quality precision resistors in multiplier circuit.
- Calibrates on both AC and DC for maximum accuracy.
- Terrific coverage — reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.
- Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.
- New styling presents attractive and professional appearance.



Heathkit 30,000V DC PROBE KIT

A new 30,000 V DC Probe Kit to handle high voltages with safety. For TV service work and all other high voltage applications. Sleek looking — Two color molded plastic — Red body and guard — jet black handle. Comes with connector, cable, and PL55 type plug. Plugs into Heathkit VTVM so that 300V scale is conveniently multiplied by 100. Can be used with any standard 11 megohm VTVM.

$5.50

**No. 336 High Voltage Probe Kit
Shipping Wt. 2 lbs.**

Heathkit RF PROBE KIT

This RF Probe Kit comes complete with probe housing, crystal diode detector, connector, lead and plug and all other parts plus clear assembly instructions. Extends range of Heathkit VTVM to 250 Mc. ± 10%. Works on any 11 megohm input VTVM. Specify No. 309 RF Probe Kit.

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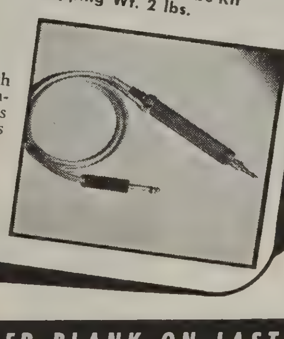
Ship. Wt. 1 lb.



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NEW 1952 *Heathkit* BATTERY ELIMINATOR KIT

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Model BE-3
Shipping Wt. 17 lbs.

- Can be used as battery charger.
- Continuously variable output 0 - 8 Volts — not switch type.
- Heavy duty Mallory 17 disk type magnesium copper sulfide rectifier.
- Automatic overload relay for maximum protection. Self-resetting type.
- Ideal for battery, aircraft and marine radios.
- Dual Volt and Ammeters read both voltage and amperage continually — no switching.

The new Heathkit Model BE-2 incorporates the best. Continuously variable output control is of the variable transformer type with smooth wiper type contacts.

There are no switches or steps and voltage between 0 and 8 Volts is available at 10 Amperes continuous and 15 Amperes intermittent. Maximum safety from overloads and shorts provided by automatic overload relay which resets itself when overload is removed.

The new rectifier is a 17 plate Mallory magnesium copper sulfide type. This is the most rugged type available for long trouble-free use.

Output is continuously metered by both a 0 - 10 Volt Voltmeter and a 0 - 15 Amp Ammeter. Shorted vibrators indicated instantly by ammeter.

Equip now for all types of service — aircraft — marine — auto and battery radios — this inexpensive instrument vastly increases service possibilities — better be ready when the customer walks in.

NEW *Heathkit* SINE AND SQUARE WAVE AUDIO GENERATOR KIT

Designed with versatility, usefulness, and dependability in mind, the AG-7 gives you the two most needed wave shapes right at your fingertips — the sine wave and the square wave.

The range switch and plainly calibrated frequency scale give rapid and easy frequency selection, and the output control permits setting the output to any desired level.

A high-low impedance switch sets the instrument for either high or low impedance output —on high to connect a high impedance load, and on low to work into a low impedance transformer with negligible DC resistance.

Coverage is from 20 to 20,000 cycles, and distortion is at a minimum — you can really trust the output wave shape.

Six tubes, quality 4 gang tuning condenser, power transformer, metal cased filter condenser, 1% precision resistors in the frequency determining circuit, and all other parts come with the kit —plus, a complete construction manual — A tremendous kit, and the price is truly low.

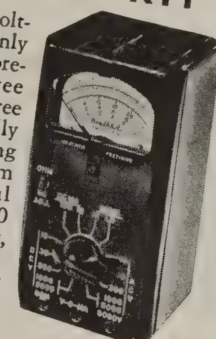
Model AG-7
Shipping Wt. 15 lbs.

$34.50

THE NEW *Heathkit* HANDITESTER KIT

A precision portable volt-ohm milliammeter. Uses only high quality parts — All precision 1% resistors, three deck switch for trouble-free mounting of parts, specially designed battery mounting bracket, smooth acting ohm adjust control, beautiful molded bakelite case, 400 micro-amp meter movement, etc.

DC and AC voltage ranges 10 - 30 - 300 - 1000 - 5000V. Ohms range 0 - 3000 and 0 - 300,000. Range Milliamperes 0 - 10 Ma, 0 - 100 Ma. Easily assembled from complete instructions and pictorial diagrams.



$13.50

Model M-1
Shipping Wt. 3 lbs.

NEW *Heathkit* T.V. ALIGNMENT GENERATOR KIT

Here is an excellent TV Alignment Generator designed to do TV service work quickly, easily, and properly. The Model TS-2 when used in conjunction with an oscilloscope provides a means of correctly aligning television receivers.

The instrument provides a frequency modulated signal covering, in two bands, the range of 10 to 90 Mc. and 150 to 230 Mc. — thus, ALL ALLOCATED TV CHANNELS AS WELL AS IF FREQUENCIES ARE COVERED.

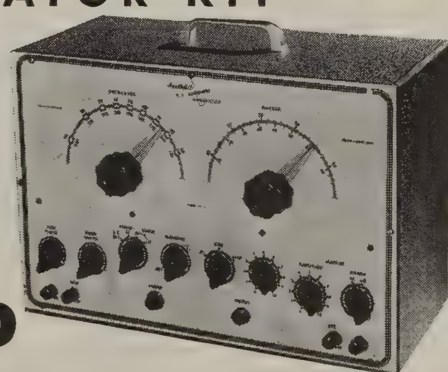
An absorption type frequency marker covers from 20 to 75 Mc. in two ranges — therefore, you have a simple, convenient means of frequency checking of IF's, independent of oscillator calibration.

Sweep width is controlled from the front panel and covers a sweep deviation of 0-12 Mc. — all the sweep you could possibly need or want.

And still other excellent features are: Horizontal sweep voltage available at the front panel (and controlled with a phasing control — both step and continuously variable attenuation for setting the output signal to the desired level — a convenient instrument stand-by position — vernier drive of both oscillator and marker tuning condensers — and blanking for establishing a single trace with base reference level. Make your work easier, save time, and repair with confidence — order your Heathkit TV Alignment Generator now!

Model TS-2
Shipping Wt. 20 lbs.

$39.50



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Heathkit RECEIVER & TUNER KITS for AM and FM

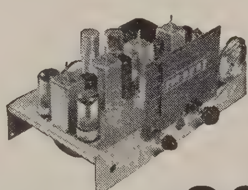
Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt. 10 lbs.

Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt. 10 lbs.

TWO HIGH QUALITY *Heathkit* SUPERHETRODYNE RECEIVER KITS

Two excellent Heathkits. Ideal for schools, replacement of worn out receivers, amateur and custom installations.

Both are transformer operated quality units. The best of materials used throughout — six inch calibrated slide rule dial — quality power output transformers — dual iron core shielded. I.F. coils — metal cased filter condenser. The chassis has phono input jacks, 110 Volt output for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.



Model FM-2
Ship. Wt. 9 lbs.

$22.50

TRUE FM FROM *Heathkit* FM TUNER KIT

The Heathkit FM Tuner Model FM-2 was designed for best tonal reproduction. The circuit incorporates the most desirable FM features — true FM.

Utilizes 8 tubes: 7E5 Oscillator, 6SH7 mixer, two 6SH7 IF amplifiers, 6SH7 limiter, two 7C4 diodes as discriminator, and 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. Has ready wound and adjusted RF coils, and 2 stages of 10.7 Mc IF (including limiter). A calibrated six inch slide rule dial has vernier drive for easy tuning. All parts and complete construction manual furnished.

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	Heathkit VTVM Kit — Model V-5			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit FM Tuner Kit — FM-2			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit Handitester Kit — Model M-1	
	Heathkit Three Band Receiver Kit—Model AR-1			Heathkit Power Supply Kit — Model PS-1	
	Heathkit Amplifier Kit — Model A-4			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Amplifier Kit — Model A-6 (or A-6A)			Heathkit Impedance Bridge Kit — Model IB-1B	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit A.C. VTVM-KIT — Model AV-1	
	Heathkit Audio Generator Kit — Model AG-7			Heathkit Intermodul. Analyzer Kit—Model IM-1	
	Heathkit Battery Eliminator Kit — Model BE-2			Heathkit Audio Freq. Meter Kit — Model AF-1	
	Heathkit Electronic Switch Kit — Model S-2			Heathkit Square Wave Gen. Kit — Model SQ-1	
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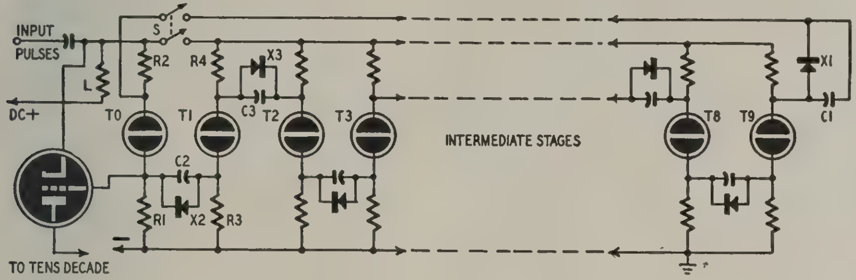
GLOW-LAMP COUNTING RING

One of the simplest electronic counters yet designed has recently been patented by Russell Sydnor Crenshaw, Jr., of the U.S. Navy. It utilizes the flip-flop characteristics of an ordinary neon or other glow-lamp. The lamp fires when fed with a voltage higher than its *striking* potential. Then conduction is maintained at some lower *operating* voltage. The lamp is triggered from one stable state (conductive or nonconductive) to the other by the pulses to be counted.

It reduces the voltage across T0 so that it cannot sustain conduction. For a moment all lamps are extinguished so the voltage across each tends to rise. Note, however, that the charge on C2 is in a direction which *adds* to the supply voltage on T1. Therefore this lamp is fired first. As soon as it passes current the voltage across the other lamps drops too low for conduction.

Now R3 and R4 are passing current. The drop across R3 biases X2 to conduction. C2 is discharged. The voltage



Each of the counter stages needs only one neon or other glow-lamp, a rectifier, several resistors, and a capacitor. The power supply may be 115 volts d.c. The counter is more compact than vacuum-tube types and does not need a filament supply. Furthermore the lamps automatically indicate the progress of the count. However, gas tubes require time to de-ionize. This limits the counting speed of the instrument.

The counter's schematic is shown above. Each decade counting ring requires ten stages, of which six are drawn here. The others are connected in a similar manner and need not be shown. Initially, only T0 conducts. This is assured by momentarily opening switches S. When they are closed again, T0 continues to pass current. Due to the voltage drop across the limiting resistor L there is insufficient potential across the other lamps to fire them.

While T0 conducts, current flows through R1 and R2. The voltage drop across R1 is in a direction to block rectifier X2 so capacitor C2 becomes charged. The direction of the voltage across R2 causes X1 to conduct so C1 cannot charge.

When a negative signal pulse arrives, across R4 blocks X3. This permits C3 to take a charge (positive terminal toward T2).

When a second negative pulse is impressed on the counter, T1 is extinguished. Again all lamps are off momentarily. The voltage on all lamps begins to rise but T2 is fired first because it is fed by the d.c. supply in series-aiding with the charge on C3. With T2 passing current, the voltage on the other lamps is reduced below the striking value.

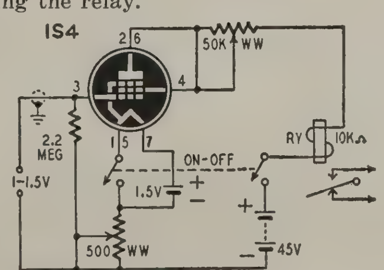
In this way the count progresses down the ring. Each successive negative pulse ignites the next lamp in line and extinguishes the previous one. The tenth pulse ignites T0 again and blocks T9. This produces a positive pulse at the T0 cathode and the control grid of the triode tube. The triode output is a negative pulse which triggers the tens decade. The latter is operated once for every ten pulses to the units decade. Additional decades may be added for hundreds, thousands, etc.

This counter will probably replace presently used circuits for many applications. It is covered by patent No. 2,549,779 and may be used by the U.S. Government without royalties.

SENSITIVE BATTERY-POWERED RELAY

Amateurs, experimenters, and builders of radio-controlled models often have need for a sensitive battery-operated d.c. relay like the one described here through courtesy of the Cornell-Dubilier Electric Corp. The relay closes when a d.c. control signal of 1 to 1.5 volts is applied to its input terminals. The control signal can be taken from a phototube, the a.v.c. line of a receiver, from a microphone and rectifier combination, or any source delivering 1 or 2 volts at a few microamperes.

To adjust the relay, set the 50,000-ohm control to the point where the relay just drops out with no signal applied to the input terminals. The relay should pull in when a control signal is applied. If it does not, adjust the setting of the 500-ohm cathode biasing resistor to the point where the relay closes when the signal is applied. Keep the input leads short and well shielded to prevent stray a.c. fields from tripping the relay.



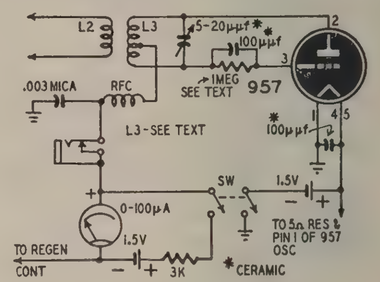
AUGUST TV FIELD STRENGTH METER MODIFIED

Readers who constructed the TV field-strength meter described on page 72 of the August issue will probably find it difficult to obtain an RK62 for the second detector. Raytheon abandoned this tube in favor of the RK61 which is the miniature version. Unfortunately production of the RK61 has been temporarily suspended because of high-priority military orders. Since there is no direct substitute which will provide the sensitivity of the RK61 or RK62, the field-strength meter has been modified to permit the use of a 957 like that used in the local oscillator circuit.

A recent issue of *Aerovox Research Worker* describes changes which permit a 957 acorn-type triode to be substituted for the RK62. The modified circuit works almost as well as the original when the original 1-ma meter is replaced by a unit having full-scale deflection of 100 μa or less. If such a meter is not available, the instrument may be fitted with pin jacks for connecting the low-current range of a multimeter. A meter having a sensitivity of 10,000 ohms per volt can be used. The revised circuit of the super-regenerative i.f. amplifier and second detector is shown.

Maximum sensitivity requires careful selection of the value of the grid resistor and careful adjustment of coupling between L2 and L3. The average value of the grid resistor is 1 megohm. Try slightly higher and lower values and vary the coupling between coils. Use the values producing greatest change in plate current for a given input signal. Two turns were added to the detector coil to compensate for the lower grid-to-filament capacitance of the 957. L3 now has 21 turns. Wire size, coil diameter, and winding length are the same as in the original model.

Because the meter in the revised circuit is more sensitive than the one used in the original circuit, special precautions must be observed to protect it against excessive current. Before installing the meter and bucking-voltage battery, connect a 1- or 2-ma meter in place of the meter shown in the diagram. Connect this meter with its positive terminal going to the arm of the regeneration control. Close both switches and adjust the regeneration control so the meter reads close to 500 μa. Carefully mark this position on the scale



of the regeneration control. Open both switches and install the 100-μa meter and battery which supplies the bucking voltage through the meter. Be sure that both meter and battery are polarized as shown in the diagram.

When operating the instrument, always close the standby switch and advance the regeneration control to the predetermined 500-μa point before closing the filament switch. When the switch is closed, plate current flows but it is bucked out by the 500-μa current flowing through the meter from the opposite direction. This produces a near-zero reading on the meter. Touch-up the adjustment of the regeneration control to bring the meter to zero. An incoming signal will cause the meter to read upward. A strong one will produce a reading of 50 to 75 μa when the value of the grid resistor and the coupling between L2 and L3 are optimum.

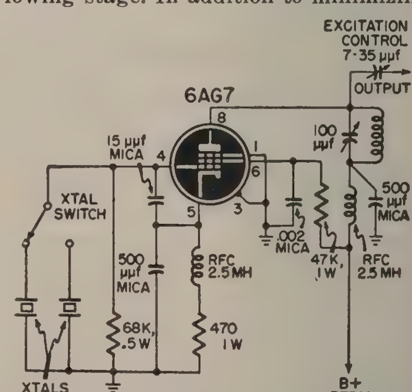
"HOT" BASIC OSCILLATOR UNIT

This crystal oscillator circuit is recommended by the Petersen Radio Company, Inc., of Council Bluffs, Iowa. It gives generous harmonic output of the crystal as high as the fourth.

The 15-μμf and 500-μμf capacitors, with the crystal acting as an inductor, make a Colpitts oscillator. The screen is used as the anode for the oscillator section. The plate circuit is tuned to the desired harmonic. The crystal oscillates at its fundamental regardless of whether the plate is tuned to a harmonic or not. A pronounced plate-current dip appears when the plate circuit is tuned to the fundamental and lesser dips when harmonics are tuned in.

This oscillator provides sufficient output on the fourth harmonic to drive a 2E26 or equivalent.

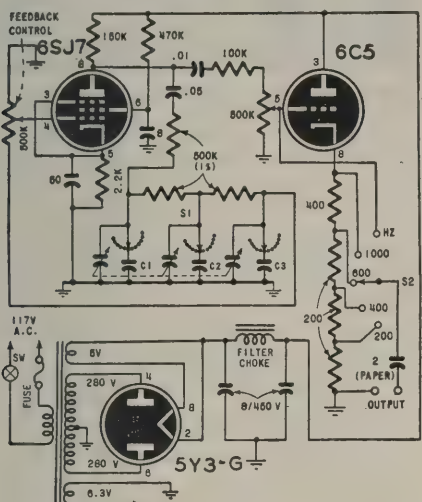
If you plan to use this oscillator on its higher harmonics, it is advisable to use link coupling rather than the impedance (capacitive) coupling shown in the diagram. Link coupling provides a means of efficient impedance matching between the stages and makes possible higher voltages on the grid of the following stage. In addition to minimizing



power losses, link coupling is a convenient means of reducing radiation of spurious signals. The latter factor is important in TV areas.

A.F. OSCILLATOR

A novel phase-shift audio oscillator which covers frequencies between 41 and 1,550 cycles in 11 ranges and from 1,550 to 10,000 cycles in the twelfth range is described in *La Radio-Revue* (Antwerp, Belgium).



The unit is tuned by a 3-gang, 500-μμf variable capacitor. Bands are selected with S1, a 3-circuit, 12-position switch (only one position shown).

The second through twelfth positions cover successively smaller tuning ranges. Coverage is continuous in the first seven ranges where the values of the padder capacitors (C1, C2, and C3 on the diagram) increase in steps of 500 μμf. Padders for the eighth through twelfth ranges vary in larger steps with the result that there are some gaps between the higher tuning ranges.

The approximate tuning range for each band and the values of the padders are shown in the table. The total

Band	Tuning range (c.p.s.)	C1, C2 C3 (μf unless specified)
1	1,550-10,000	Not used
2	810- 1,550	500 μμf
3	550- 810	.001
4	415- 550	.0015
5	330- 415	.002
6	275- 330	.0025
7	240- 275	.003
8	185- 210	.004
9	153- 168	.005
10	112- 120	.007
11	81- 85	.01
12	41- 43	.02

capacitance required in each of the capacitor sections to tune a given frequency is: $C = 850{,}000/f$ where C is in μμf and f is in cycles.

The 500,000-ohm potentiometer between the R-C network and the control grid of the 6SJ7 should be adjusted for best waveform and stability over the tuning range. The control in the grid circuit of the 6C5 cathode follower varies the output. Switch S2 varies the low-impedance output. High-impedance output is taken from the HZ terminal connected to the 6C5 grid.

—end—

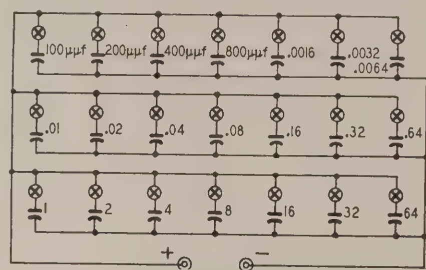
HANDY TOOL FOR COAX

A Gillette office knife is a handy item to keep around the shop or shack. This rugged knife is constructed like a scalpel and its replaceable blades are razor sharp. Its full-size handle fits the palm so you can apply enough force to make a clean cut in or through coax—even RG-8/U. If you have previous experience at cutting RG-8/U, I'm sure you will appreciate the clean cuts which can be obtained.

The knife can be purchased at most stationery and office-supply stores for about a dollar, and replaceable blades are only a few cents each.—*Milton Kalashian, W1NXT*

CAPACITOR SUBSTITUTION BOX

For the past several months, I have been using a capacitor substitution box which I find very useful in TV and radio servicing. Using only 21 capacitors and an equal number of s.p.s.t.



switches in the circuit shown, I can cover a range of 54 different capacitances. The components are mounted in a 4 x 5 x 9-inch metal box with switches and terminals on the front. Connections are made so stray capacitance is minimized.

You won't realize how handy one of these little gadgets can be till after you have used it for a few weeks.—*George E. Row*

TV CHASSIS SUPPORT

When servicing TV sets, it is often necessary to stand the chassis on end to expose the wiring underneath. When the picture tube and deflection yoke are mounted on the chassis, the assembly is very top-heavy, making it difficult to keep the chassis in a position convenient for under-chassis servicing.

I have solved the problem by using stiff wire hooks suspended by adjustable straps fastened to the ceiling or a shelf above the workbench. The chassis can be safely supported in any convenient position by engaging the hooks at the top end. This system permits the assembly to be pivoted when making adjustments on both the top and under sides of the chassis.—*Hyman Herman*

USING 160-METER XTALS

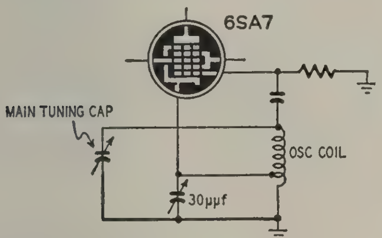
If you have any crystals from the old 160-meter band, you can probably put them to work on 6 meters if they are between 1852 and 2,000 kc. Most of these crystals will oscillate on their third harmonic without any special multiplier or feedback circuits. Thus, you can hit 6 meters by using a simple oscillator followed by two low-power triplers.—*S. H. Beverage, W1MGP*

FILE CARD TUBE DATA

Being tired of having my tube manual closing up or its pages turning over while in use, I bought another copy and a set of file cards and proceeded to cut up this copy and paste the base diagram and characteristics on the cards. Now, I slide out each card as I need it and it stays put.—*Fred F. Davis*

SIMPLE BANDSPREAD TUNING

My receiver covers the 550 to 1600-kc broadcast and 5 to 18-mc short-wave bands. Tuning was so critical on 14 mc that it was almost impossible to separate the stations until I installed a small bandspread tuning capacitor in the oscillator circuit. The capacitor was



first connected in parallel with the oscillator section of the main tuning gang, but I found that considerably more spread was obtained by connecting it between ground and the cathode tap on the coil as shown in the diagram. The capacitor was installed close to the oscillator coil and a flexible coupling added to bring the control shaft through the front panel on the set.—*M. Dalla*

THREADING RODS

Short lengths of threaded brass, copper, and fiber rods are often needed in experimental work. If you do not have a die which will do the job, you can often use a steel nut of the proper size and with a clean-cut thread. With the unthreaded rod held tightly in a vise, you can, by applying considerable pressure, screw the nut onto the rod. When the nut is backed off, it will leave a perfect thread.—*Oscar E. Malech*

(It helps to file or grind a conical end on the rod so the nut can be slipped over it, making the cut easy to start. Another trick is to select a nut one size larger than normal and cut a slot through one side with a hacksaw. Slip the nut over the rod, then grip the nut tightly in a vise so that the pressure closes the gap, causing the threads to bite into the rod.—*Editor*

OSCILLATOR CIRCUIT KINK

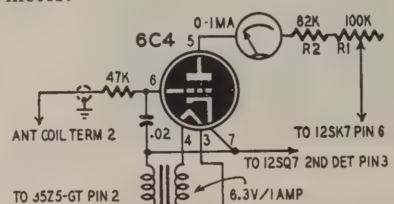
When wiring in the grid leak of a superhet oscillator or converter, do not ground the bottom end of the resistor; bring it to a tie point and connect a resistor of 500 to 1,000 ohms between that point and ground. You now have a test point for checking oscillator grid current without breaking the circuit to insert the meter. The added resistance is large enough to prevent it from affecting the meter reading, yet so small it will not affect circuit operation.—*Charles Erwin Cohn*

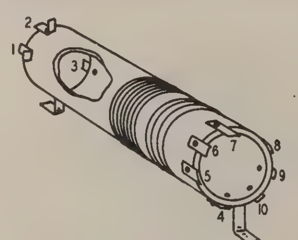
—end—

S-METER FOR S-38 RECEIVER

? *Please print a diagram of an S-meter which I can add to my S-38 receiver. I do not have a diagram of the set, so please show the points to which I must connect the meter circuit.—J. L. S., New York, N. Y.*

A. The S-meter circuit shown in the diagram was described in detail in the August, 1948, issue. It has been modified slightly to permit its use in the Hallicrafters S-38 receiver. Since this set has series-connected heaters, it is simpler to use a small filament transformer for the 6C4 meter tube than it is to rewire the heater string in the set. The grid of the 6C4 connects to the a.v.c. line in the set. This connection can be made to terminal 2 of the antenna transformer. A drawing of the transformer and its terminal numbers is shown below the schematic of the S-meter.



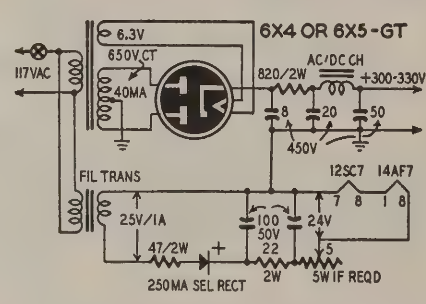


Short-circuit the antenna terminals and adjust R1 so the meter reads full scale. The needle should fall to zero on a strong local station. If it does not, try varying the value of R2.

AUDIO PREAMP POWER SUPPLY

? *Please design a power supply which will deliver d.c. plate and heater voltages for the preamplifier and equalizer described in the article "Engineered Amplifier Brings Audio Realism" in the February, 1951, issue.—O.R.N., Jr., Cornwells Heights, Pa.*

A. The power supply shown delivers well-filtered plate voltage for the plates

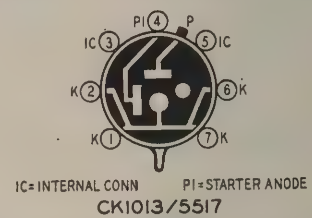


of the tubes as well as 24 volts d.c. at 150 ma for the heaters. The 5-ohm variable resistor is required only if the output from the heater supply exceeds 24 volts. The filament transformer may be a Stancor type P-6469 or equivalent.

TUBE BASE AND DATA

? *I have a Raytheon CK1013/5517 tube which I want to use in a strobe flash unit. Please print pin connections and the voltage and current ratings on this tube.—O. C. A., Holloman AFB, New Mexico.*

A. The CK1013/5517 tube mounts in a 7-pin button socket with pin connections as shown. The plate connects to the top cap. The exhaust tip comes out



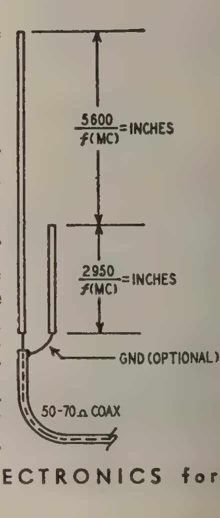
the side of the envelope in the sector between pins 1 and 7. Pins 3 and 5 are internal connections which cannot be used as tie-points and must not be connected to any external circuit except the cathode.

The tube is a half-wave, cold-cathode, gas-filled rectifier. Maximum r.m.s. supply voltage is 1,200 and the minimum is 550. Average cathode current is 6 ma. The maximum safe cathode current (steady state) is 50 ma and the maximum surge current is 150 ma. A resistance of about 10,000 ohms should be used in series with the plate so the plate current will not exceed these values. The starter anode connects to the plate through a 10-megohm resistor to limit its current. Plate-to-cathode drop is 100 volts at 6 ma cathode current.

ANTENNA FOR 152-162 MC

? *I have a receiver for use in the 152–162–mc band and would like to have construction details on a vertical antenna to use with it. Can you help me?—C. C., Newark, N. J.*

A. A number of vertical antennas can be used for v.h.f. communications. Perhaps the simplest is the "J" antenna shown in the diagram. It consists of a vertical half-wavelength radiator fed at the base through a quarter-wavelength matching section. If the antenna is to be used for reception throughout the band, the total length of the longer section should be approximately 54¼ inches and the shorter leg should be 19 inches long. The antenna may be made from rods ¼ to ½ inch in diameter. They should be spaced 3 to 4 inches apart for use with coaxial cable between 50 and 80 ohms. The inner conductor of the radiator line connects to the base of the radiator and the outer conductor to the bottom of the shorter element. This point may be connected to a



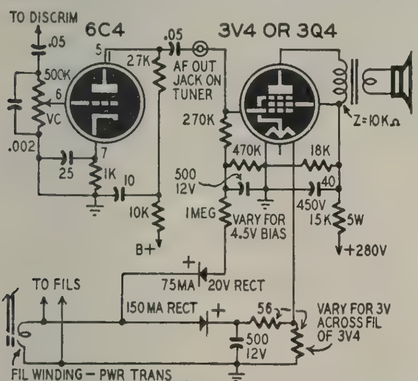
grounded metal mast to provide protection against lightning.

If the antenna is to be used mainly for reception on one frequency, use the formulas shown on the diagram to compute the lengths of the radiator and matching stub.

AUDIO FOR FM TUNER

? I have a Meissner model 8C FM tuner to which I would like to add a power amplifier which can be operated from the tuner's power supply and will supply enough power for a small PM speaker. Can you tell me how to do this? —H. D., New York, N. Y.

A. The power supply of the tuner is operating close to maximum capacity, so



we have designed a power amplifier using a battery-type amplifier tube instead of one of the 6-volt types which draw considerably more plate and screen current. The 3V4 or 3Q4 draws a total of about 10 ma as compared to 40 ma or more for 6-volt tubes. Filament and bias voltages are obtained by rectifying voltage obtained from the heater winding on the power transformer.

PHILCO 38-116 AS TUNER

? I have a Philco model 38-116 receiver which I want to convert to a tuner for use with a high-fidelity amplifier and speaker system located in the basement. Please tell me how I can remove the audio circuits in the set without disturbing the fixed bias applied to the other tubes.—O.M.B., Flint, Mich.

A. With the set operating normally, measure the cathode currents of the 6J5 driver and push-pull 6L6-G output tubes. Add the cathode currents. Now measure the voltage on the screen grid of one of the 6L6's. Remove the 6J5 and 6L6's from the circuit along with all resistors and capacitors immediately associated with their plate and grid circuits. Do not remove the resistors which supply grid bias for the 6J5, as this network also supplies bias for the 6R7-G first a.f. tube.

A bleeder resistor must be connected between the output side of the 85-ohm filter choke and ground. The value of the resistor must be adjusted so the bleeder current equals the total cathode currents of the 6J5 and 6L6 tubes. Bleeder resistance is found by dividing the normal B-plus voltage by the bleeder current. Its wattage rating should be about 25% higher than the

value found by multiplying the B-plus voltage by the bleeder current in amperes.

Replace the 51,000-ohm plate-load resistor for the 6R7-G with a high-fidelity transformer designed to match a medium-mu triode to a 500-ohm line. Use a good grade of audio cable to connect the secondary of the plate-to-line transformer to the 500-ohm input of your amplifier.

If the amplifier does not have a 500-ohm input, a good line-to-grid transformer must be used between the line and the input to the amplifier.

LOOP ANTENNA DATA

? *Please print constructional details on a loop antenna for use between 1600 kc and 3.8 mc. I would like to be able to use the loop for direction finding.—R. R. R., Brentwood, L. I.*

A. The number of turns in the loop depends on the frequency range, stray capacitance, proximity and type of shield, and many other factors. The larger you make the loop, the better it will work.

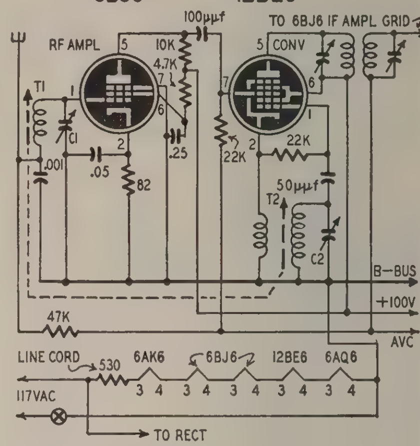
Wind a few turns of wire on the form or frame and connect the loop in the circuit of a Colpitts oscillator. Use a frequency meter or short-wave receiver to determine the frequency range.

Note that in a Colpitts circuit, each section of the tuning capacitor must have twice the value of the capacitor which will be used to tune the coil when used as a loop antenna. Thus, if you plan to tune the loop with a single-section 365-μμf capacitor, each section of the oscillator-tuning capacitor should have a capacitance of 730 μμf. You can use a four-section broadcast capacitor with the sections connected in pairs. After determining the range of the coil in the oscillator, you can add or remove turns to get the exact range that you want.

MIDGET MODIFICATION

? *In the article "Heat Reduction in Midget Sets" in the June, 1949, issue, the author suggests the addition of an untuned r.f. amplifier to the circuit of a 4-tube superhet. Please prepare a diagram showing how this can be done.—G. G. M., Oak Ridge, Tenn.*

A. In most cases, we consider an untuned r.f. amplifier as being one in which the antenna is connected to a broad-band input circuit. Tuning takes



place after the r.f. amplifier. In areas where there are a number of strong local stations, all are amplified equally before reaching a tuned circuit. This condition often causes severe heterodyning and cross-modulation. Such troubles can be minimized by tuning the antenna input circuit and using resistance-capacitance coupling between the r.f amplifier and converter as shown in the diagram. A 6BJ6 is used as the r.f. amplifier. The line-dropping resistor is decreased to 530 ohms to compensate for the r.f. tube which has been inserted in the heater string.

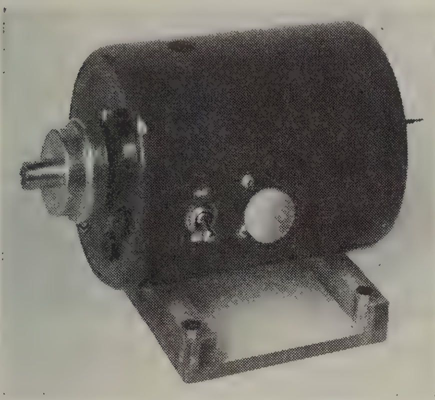
—end—

Suggested by: Herman Robeson, French Lick, Ind.

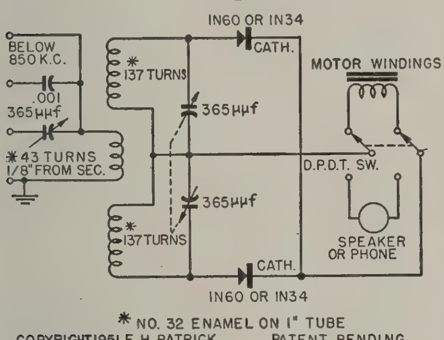
"Neighbors been complaining about its volume again?"

A RADIO MOTOR

It has been many years since a motor designed to operate on the power delivered by a broadcast antenna has been announced. Previous ones described in Gernsback publications operated on the electrostatic principle. Consequently the editors of RADIO-ELECTRONICS were much interested when the inventor brought to us the device pictured here—a genuine dynamic motor designed to operate off a broadcast antenna. The motor itself is in the right-hand section of the case (in the photo of the opened motor). It is—as can be seen in the photo—a D'Arsonval movement; a microammeter with a pair of light-contact commutator wires instead of the fixed connections of the standard meter. Consequently, when a strong station is tuned in and the meter coil swings over, instead of bringing the indicator over against the pin, it simply turns it far enough to reverse the connections to the commutator, causing it to move another half turn—in other words, to behave like a true motor.



"Pulley" is the radio dial—motor shaft may be seen extending from the far end.



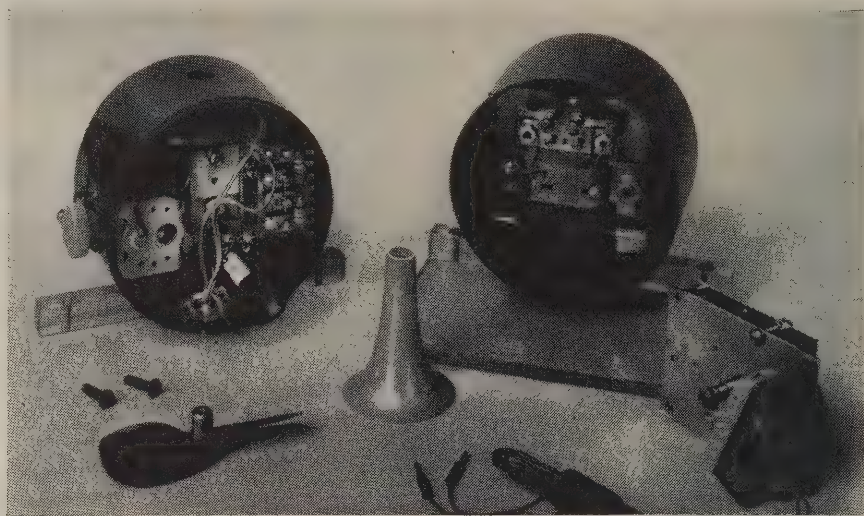
A schematic of the radio power source.

The inventor claims to have obtained enough power from this unique device—when used close to a broadcast station—to operate a microswitch through the reducing-gear train shown in the right foreground. Thus it could (for example) start the breakfast coffee as the local station started its morning program.

The receiver consists of a push-pull crystal rectifier, efficiently coupled to an antenna circuit. Both antenna and secondary circuits are tuned, and an antenna about 200 feet long and as high as possible is recommended.

The main tuning knob is at the end; the small one at the side operates the antenna tuner. The switch changes the

set from speaker to motor. The speaker consists of a large 2,000-ohm phone unit, mounted just below the hole in the top of the case.



Courtesy Scientific Products of Indianapolis

Receiver (left) and motor (right) with reducing gears, horn and other equipment.

"Transatlantic Crossing" Remembered

30 years ago on December 11, 1921, a group of six amateurs sent the first shortwave message across the Atlantic Ocean. The message, which was picked up in Ardrossan, Scotland, by Paul Godley, opened the door for intensive work and developments in shortwave communications and forever killed the theory that "wavelengths below 200 meters are useless."

Exactly 20 years before (December 12, 1901) Marconi—also using short wavelengths—had received a single letter across the Atlantic. Since then there had been no verified report of successful communication at such short wavelengths and the exploit had dropped to the status of a legend in the minds of communication engineers. But by 1921 reports of British reception of American amateur signals had been seeping through with enough insistence to persuade the American Radio Relay League to check and to make an official test. Paul Godley, one of America's leading amateurs, was sent to Scotland, and the hams on this side set about building a station that "would get across."

The site of Minton Cronkhite's station 1BCG was chosen and a "T" antenna 100 feet long and 70 feet high at the center was erected. The transmitter used two 250-watt tubes of the then standard UV-204 type.

Till the last minute the operating staff were busy making final adjustments and they sent out the first messages while "we were still having some condenser troubles and keying difficulties." Nevertheless, the signals got through, and on the fourth night of the tests "transatlantic message Nr. 1" was transmitted to Godley.

Last year, the Radio Club of America erected the stone shown in the photograph to commemorate one of the most decisive transmissions in the history of radio.

Four original operators of 1BCG, first shortwave station to transmit a trans-Atlantic message, were present at the dedication of a memorial to that station (Radio-Electronics, Sept., 1950). From left to right the men are: Major Edwin H. Armstrong, George E. Burghard, Paul F. Godley, and Ernest V. Amy.

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

RADIO-TV CATALOG

The 1952 Catalog No. 95 has been issued by Concord Radio Corp. It features a wide variety of electronic components, sound units, tuners, test equipment, and reference books. Gratis from Concord Radio Corp., 901 W. Jackson Blvd., Chicago 7, Ill.

CONSERVATION HANDBOOK

RCA's "Handbook on Conservation Materials" discusses a number of subjects, including stretching antenna installation material and future possibilities in material economy. Possibly the most interesting part to the TV and radio repair technician is the 10-page section, "Alternate Tube Types," which is followed by a shorter section, "Alternate Replacement Parts," giving alternate component numbers for a large number of RCA parts.

Available from E. C. Buurma, RCA Service Company, Inc., Camden, N. J.

COMPONENT INFORMATION

Centralab has published two catalogs—one on switches, describing its various types of multipole gang and other switches for all electronic devices, and one covering its line of *T. C. Hi-Kaps* (temperature compensated ceramic capacitors)—as well as a number of leaflets on special high-frequency and small-space capacitors, miniature printed-circuit mounting assemblies, etc.

Available to interested parties on letterhead request to Centralab, 922 E. Keefe Ave., Milwaukee 1, Wis.

ALLIED RADIO CATALOG

The new 1952 Allied Radio catalog contains 212 pages, with comprehensive listings of the items familiar to Allied customers. Of especial interest are the sections on Geiger counters, sound equipment, and amateur radio supplies.

Available from Allied Radio Corp., 833 West Jackson Blvd., Chicago 7, Ill.

RADIO-TV CATALOG

The Burstein-Applebee Co. 1952 Catalog No. 521 features a wide variety of electronic components, test equipment, home and auto communication sets, TV sets, shop tools, reference books, and household appliances.

Copy is gratis by writing to Burstein-Applebee Co., 1012-14 McGee St., Kansas City, Mo.

TV ANTENNA CATALOG

The line of Louis Bros. antennas and chassis cradle is covered in a booklet put out by Louis Bros., 3543 East 16th St., Los Angeles 23, Cal. It lists all-band and Yagi-type antennas. Gratis.

THE FUND REACHES $8,877

HELP-FREDDIE-WALK FUND

We are happy to report that the interest of our readers in little Freddie Thomason, the armless and legless three-year-old son of radio technician Herschel Thomason, continues to be evidenced by their contributions to the Help-Freddie-Walk Fund, which this month reaches a grand total of almost $8,900.00.

Freddie and his mother have just returned from another visit to the Kessler Institute, and he continues to make progress. However, it will be an "uphill climb" for many years to come before Freddie will be able to confidently face the world around him, and many thousands of dollars will be needed to assure him those mechanical appliances upon which he will be dependent throughout his life. We are certain that the diligent and unselfish efforts of Freddie's parents and doctors will be matched by the wholehearted cooperation of our many readers who are able to contribute to such a worthy cause.

We are pleased to note the following group contributions received this month:

Donated by Sigma Tau Omega members, San Francisco, California, through the efforts of Mrs. John R. Skinner............$5.00

Donated by the Toll Operators, New York Telephone Company, Buffalo, New York, through the efforts of I. McAllister.....$15.50

Another "group contribution" received this month was that of $12.00 donated by the Airborne Communications, 71st Ftr. Intcp. Sq., Coraopolis, Pennsylvania, through the efforts of Lt. Edward T. Kosek, who says that his men responded readily to Freddie's appeal when he brought it to their attention.

No contribution is too small for our notice and each is acknowledged with sincere thanks and appreciation; please send them from time to time, whenever you are able.

Make all checks, money orders, etc., payable to Herschel Thomason. Please address all letters to:

Help-Freddie-Walk-Fund
c/o RADIO-ELECTRONICS
25 West Broadway,
New York 7, New York

FAMILY CIRCLE CONTRIBUTIONS

Balance as of September 19, 1951	$457.50
M. Finkelstein, Brooklyn, New York ...	2.00
Lillian Jung, Brooklyn, New York	5.00
Leonora V. Murphy, North Syracuse, N. Y.	5.00
Mrs. D. Newton, El Cajon, California	1.00
Mrs. Mary F. O'Dwyer, Hartford, Conn.	1.00
Sigma Tau Omega Members, San Francisco, Calif.	5.00
Helen White, Bois D'Arc, Missouri ...	1.00
FAMILY CIRCLE Contributions Received up to October 18, 1951	$477.50

OPPORTUNITY AD-LETS

Advertisements in this section cost 35c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for Feb. issue must reach us not later than December 21, 1951. **Radio-Electronics, 25 W. Broadway, New York 7, N. Y.**

Offers over 20 years experience and large following of electrical and electronic equipment manufacturers in Chicago and Midwest. Open to one or possibly two additional lines. Send full particulars to Box D12-51, Radio-Electronics, 25 W. Broadway, New York 7, N. Y.

RADIO OFFICERS, $600+ monthly earnings, plus top union conditions. Men with 6 months American Merchant Marine radio operating experience since Jan. 1935 can obtain special FCC license to sail immediately. Men with FCC radiotelegraph 2nd class license and 6 months sea time on Navy ships as radiomen can also qualify. Phone, wire, or write American Radio Ass'n CIO, 5 Beekman St., NYC. Cortlandt 7-6397.

SPEAKERS REPAIRED at wholesale prices. Guaranteed workmanship. Fast service. Amprite Speaker Service, 70 Vesey St., New York 7, N. Y.

MAGAZINES (BACK DATED)—FOREIGN, DOMESTIC—Arts, Books, booklets, subscriptions, etc. Catalog 10c (refunded). Cicerone's, 86-22 Northern Blvd. Jackson Heights, N. Y.

WE REPAIR, EXCHANGE, SELL, ALL TYPES OF electrical instruments, tube checkers and analyzers. Hazleton Instrument Co. (Electric Meter Laboratory), 140 Liberty Street, New York, N. Y. Telephone—BArclay 7-4239.

WANTED: AN/APR-4, other "APR-", "ARR-", "TS-", "IE-", ARC-1, ARC-3, ART-13, everything Surplus. Special tubes, Tech Manuals, Lab quality Test Equipment, etc. Describe, price in first letter. Littell, Farhills Box 26, Dayton 9, Ohio.

MEISSNER ANALYST LIKE NEW $50. L. Miller, 2106 Hildarose, Silver Spring, Md.

AMATEURS — RADIO ENGINEERING QUESTIONS Answered $1.00 With Schematics $2.50. Henry Twillmann, R R. #1, Chesterfield, Missouri.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) of RADIO-ELECTRONICS, published monthly at Philadelphia, Pa., for October 1, 1951.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Radcraft Publications, Inc., 25 West Broadway, New York 7, N. Y.; Editor, Hugo Gernsback, 25 West Broadway, New York 7, N .Y.; Managing Editor, Fred Shunaman, 25 West Broadway, New York 7, N. Y. Business Manager, none.

2. The owner is: Radcraft Publications, Inc., 25 West Broadway, New York 7, N. Y.; H. Gernsback, 25 West Broadway, New York 7, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

H. GERNSBACK, Publisher.

Sworn to and subscribed before me this 28th day of September, 1951. [Seal] Maurice Coyne, Notary Public. (My commission expires March 30, 1952.)

RADIO-ELECTRONICS CONTRIBUTIONS

Balance as of September 19, 1951	$8,250.93
George Adams, Jeddo, Pa.	1.00
Airborne Communications, 71st Ftr. Intcp. Sq., Coraopolis, Pa.	12.00
The Alotrico, Jrs., Yonkers, N. Y.	3.00
Anonymous, Dudley, Mass.	2.50
Anonymous, Glens Falls, N. Y.	1.00
Cpl. Eudarel C. Bastian, Cherry Point, N. C.	2.00
W. G. Chandler, Lemon Grove, Calif.	2.00
Guy S. Cornish, Cincinnati, Ohio	1.00
E. C. Faust W9POG, Paducah, Ky.	2.00
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Frank Gabinowitz, Long Branch, N. J.	2.00
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The Radio Shop, Tooele, Utah	13.00
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Schroeders, San Antonio, Texas	1.00
Joe Selan, Ecorse, Michigan	1.00
Bobby & Landy Small, Long Beach, Calif.	10.00
Wesley W. Smith, Philadelphia, Pa.	1.00
W. H. Strupper, New Vienna, Ohio	5.00
Toll Operators, N. Y. Tel. Co., Buffalo, N. Y.	15.50
William E. Tucker, Pittsburgh, Pa.	5.00
Edward F. Wielgot, Chicago, Ill.	5.00
Mr. & Mrs. Maurice J. Wilson, Del Paso Heights, Calif.	1.00
RADIO-ELECTRONICS Contributions Received up to October 19, 1951	$8,399.60
FAMILY CIRCLE Contributions	477.50
TOTAL RECEIPTS to October, 1951	$8,877.10

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

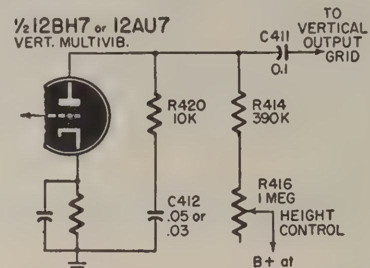
DECEMBER, 1917
ELECTRICAL EXPERIMENTER

Locating the Submarine by Radio by H. Winfield Secor
How I Telegraph Pictures by J. H. Leishman
Women Radio Operators
Interesting New Radio Apparatus
Phonograph Teaches Wireless Code Quickly
Dr. L. W. Austin on the Audion
The Audion and the "Edison Effect" by George Holmes
The How and Why of Radio Apparatus
How to Operate Audion on 110 Volts D.C. by Norman A. Woodcock

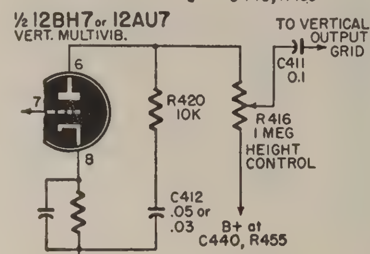
—end—

WESTINGHOUSE H-626T16, H-630T14

Due to variations in characteristics of 6K6-GT vertical output tubes, a change has been made in the height-control circuit of later production models to provide increased control over picture height.



a



b

The original circuit is shown at *a* and the modified circuit at *b*. R414 is removed from the circuit and the height-control wiring changed as shown. In later production, capacitor C412 was changed to .03 μf in the V-2172 chassis only.—*Westinghouse Service Dept.*

PHILCO 46-350

If the volume is low and the sound distorted, check the 1U5 screen-dropping resistor. This resistor is likely to be open or it may have increased its resistance to a value far above the 3.3-megohm normal value.—*Andrew Ordog, Jr.*

RCA 6T74 RECEIVER

After the set had been in operation for a few minutes, the picture would shrink, leaving a dark strip at top and bottom of the mask. Suspecting trouble in the vertical deflection circuit, we interchanged the 6K6-GT audio-output and vertical-sweep tubes. This cleared up the trouble and the picture filled the screen. After a short period of normal operation the picture shrunk again; this time from the sides. Replacing the 5U4-G low-voltage rectifier cleared up the trouble permanently, although again interchanging the 6K6-GT's caused a return of the trouble in the vertical output circuit. Since one of the tubes did not work well in the sweep circuit, we replaced it rather than have trouble later in the audio circuit.—*James H. Bell*

DU MONT RA-113

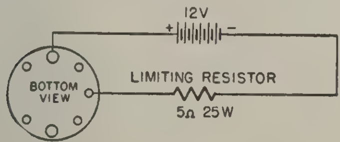
If a set of this model comes in with no high voltage, turn on the set and remove the damper tube (6W4-GT) from its socket. If the raster appears with heavy foldover on it, the trouble can be traced to a leaky capacitor (C291) in the boosted-voltage circuit. Replace this with a .02-μf, 600-volt capacitor to prevent future breakdown of this component.—*James T. Smith*

SENTINEL 400-TV

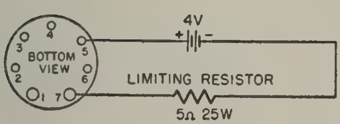
If the set is dead with no sound or video, the trouble is likely to be caused by a shorted screen bypass capacitor in the video i.f. circuit. This trouble occurs most frequently in the third i.f. amplifier but it can occur just as easily in the others. Use a 600-volt, .005-μf capacitor as a replacement.—*Wilbur J. Hantz*

VIBRATOR POWERED SETS

When a vibrator has not been used for several months, it may fail to start when placed in service. This may be caused by an insulating film which forms on the contacts. The vibrator may be restored to normal operation by applying momentarily twice the normal operating voltage to the magnet through a 5-ohm resistor. The vibrator should start to operate immediately (listen for vibration). It should then



a



b

operate on normal voltage in the receiver. Be sure that the battery is fully charged and that terminals are clean and bright.

The drawing at *a* shows connections for the vibrator (stock No. 35543) used in the RCA QB11, QB12, and QB13. The drawing at *b* is the test setup for the vibrator used in the RCA 65BR9.—*RCA Service Bulletin*

TRUETONE C2906

Some of these models have 35W4 and the others have 35Z5-GT rectifiers. In some of the latter types, the heater string begins at the pilot-light tap (pin 3) of the 35Z5-GT instead of pin 2. This causes excess voltage to be applied to the heater string, thereby reducing the normal life of the tubes. Connecting the line to pin 2 instead of pin 3 will result in longer tube life.—*Howard McCall, W8TNF*

TVI FROM CHRISTMAS TREE

Last year during the Christmas holidays, we received a number of complaints of flutter and dark moving horizontal lines on TV sets which had built-in antennas or were used with indoor antennas.

The trouble was traced to the use of metallic tinsel as decoration on Christmas trees. Any slight movement of the tree set the tinsel in motion, causing reflections which produced the symptoms. The trouble was cleared up by moving the set or antenna into another room.—*William R. Brown, Jr.*

—end—

People

Harold Harris, sales manager of CHANNEL MASTER CORP., was elected president of the Antenna Manufacturers Association, succeeding M. S. Hoth, jobber sales manager of The Radiart Corp. **Kenneth S. Brock**, advertising and sales promotion manager for WARD PRODUCTS and WORKSHOP ASSOCIATES, Divisions of the Gabriel Co., was elected vice-president of the Association. **Edward Finkel**, JFD MANUFACTURING CO., continues as treasurer.


H. Harris

Michael D. Kelly, former assistant television sales manager of THE HALLICRAFTERS CO., Chicago, was promoted to the position of television sales manager. Other Hallicrafters executive appointments include: William J. Halligan, Jr., radio sales manager; William S. Wright, operations manager; Fred T. Page, controller; Randolph W. Westerfield, executive staff member, and J. C. Matthews, chief purchasing agent. Hallicrafters also announced the appointment of John S. Mahoney, sales promotion manager, to the position of advertising manager, succeeding Charles J. Nesbitt who resigned to join the creative staff of Critchfield & Co.

Ricardo Muniz was appointed vice-president in charge of operations of the TRAD TELEVISION CORP., Asbury Park, N. J. He will be in complete charge of engineering and production functions. Mr. Muniz, formerly general manager of the Television Receiver Manufacturing Division of Du Mont Laboratories, is known to our readers as the author of several articles for RADIO-ELECTRONICS and other Gernsback publications.


R. Muniz

Charles A. Hansen, JENSEN MANUFACTURING CO., president of the Radio Parts and Electronic Equipment Shows, appointed the following committee chairmen for the 1952 Electronics Components and Equipment Show to be held in Chicago the week of May 18: Credentials, Arthur C. Stallman, Stallman of Ithaca; Budget, Lew W. Howard, Triad Transformer Manufacturing Co.; Entertainment, W. D. Jenkins, Radio Supply Co.; Housing, John H. Cashman, Radio Craftsmen, Inc.; Publicity, Jerry Kirshbaum, Precision Apparatus Co.; Educational, Jack A. Berman, Shure Brothers, Inc.

John H. Cashman, RADIO CRAFTSMEN, INC., chairman of the Association of Electronics Parts and Equipment Manufacturers, named the following chairmen for EP & EM committees for the coming year: Catalog, W. J. Barron, Merit Transformer; Credit, Joe Morin, Shure Brothers; Social, Ken Hathaway, Ward-Leonard; Educational, Les Thayer, Belden Manufacturing; Publicity, Frank Florsheim, Columbia Wire; Mo-

bilization, S. N. Shure, Shure Brothers; Industrial Relations, Jerome J. Kahn, Standard Transformer Corp.; Membership, Charles Hansen, Jensen Manufacturing Co.

Personnel Notes

. . . **W. L. Parkinson**, General Electric, and Fred D. Wilson, DuKane Corp., were named chairmen of the RTMA Service and School Equipment Committees, respectively.

. . . **Mrs. Douglas Horton**, who commanded the WAVES in World War II, has been elected to the Board of Directors of RCA. She is the first woman to serve on the board. She succeeds Arthur E. Braun who resigned.

. . . **James Lippman** has rejoined the National Co., Malden, Mass., in the newly created position of customer service manager.

. . . **Jack Thomas** has joined the engineering staff of Technical Appliance Corp., Sherburne, N. Y., in the Government Contract Division. He was formerly with the Antenna Laboratories of Ohio State University.

. . . **Robert T. Borth** has been appointed to the newly created position of manager of employee relations for the Tube Department in General Electric, with headquarters in Schenectady, N. Y. He was previously manager of community relations in New York City.

. . . **Don Haines** has joined Belmont Radio Corp. in an administrative capacity as assistant to William Garstang, administrative director of engineering and research. He was formerly chief engineer at Sentinel Radio.

. . . **Dr. Newbern Smith**, chief of the Central Radio Propagation Laboratory of the National Bureau of Standards in Washington, D.C., was awarded the 1952 Harry Diamond Memorial Award by the Board of Directors of the Institute of Radio Engineers. The award is made annually to a person in Government service who has made outstanding contributions to the field of radio and electronics.

. . . **David Gnessin** has been appointed sales manager of Transvision, Inc., New Rochelle, N. Y. Mr. Gnessin, formerly factory representative in Columbus, Ohio, has been a frequent contributor to Radio-Electronics.

. . . **Arthur W. Burten** has joined the Astron Corp., East Newark, N. J., as advertising manager and a member of the Sales Department. He has been associated with the radio industry for a number of years in both sales and advertising.

. . . **George Wedemeyer**, president of NEDA, appointed the following distributors to the Board of Directors of the Radio Parts and Electronic Equipment Shows, Inc.: Byron Deadman, Green Bay, Wis.; Anthony Dybowski, Buffalo, N. Y.; Louis W. Hatry, Hartford, Conn.; W. D. Jenkins, Richmond, Va.; H. E. Ruble, Dayton, Arthur C. Stallman, Ithaca, N. Y.; L. F. Waelterman, St. Louis.

. . . **Louis Selsor** has joined the National Video Corp., Chicago, as jobber sales manager. He formerly held sales positions with Du Mont and Thomas Electronics.

. . . **Myer Fried**, retired U.S. Army colonel, has been retained by the RCA Service Co., Camden, N. J., as special advisor to P. B. Reed, vice-president in charge of the Government Service Division.

. . . **Ray R. Hutmacher** was elected vice-president in charge of the Contract Division of Sound, Inc., Chicago. The firm, with its affiliated companies, Star Products Co. and The Pentron Corp., is a manufacturer of magnetic tape recorders, tape players, amplifiers, and other electronic products. Mr. Hutmacher was formerly with Permoflux Corp., Chicago.

. . . **Dale Cropsey** recently joined Potter and Brumfield, Princeton, Ind., as works manager.

—end—

WEED OUT THE CROOKS?

Dear Editor:

There has been much talk around here lately of licensing TV technicians. The twofold purpose of doing so is supposedly to weed out the crooks and the technically unfit.

Let me remind the advocates of licensing that the medical profession, despite having the most strictly enforced licensing plan in the world, is cursed with frauds and quacks.

LEONARD LEE LAMASCUS
Los Angeles, Cal.

CONVERSIONS OUTDATED?

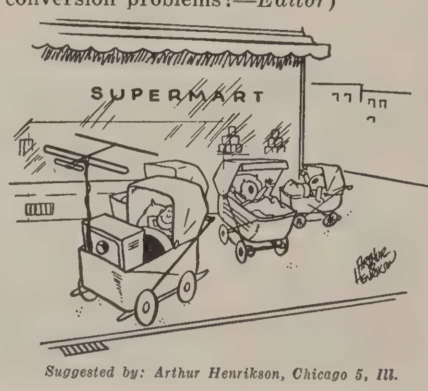
Dear Editor:

I do not intend to renew my subscription to RADIO-ELECTRONICS. Here's why! Over 50% of the August issue of the magazine was devoted to big-picture TV conversion. Thirteen months ago, when these conversion jobs were in demand, and there was a real need for the material, RADIO-ELECTRONICS carried practically no articles on this topic. Now, when all progressive service technicians are well acquainted with the problems of conversion, you devote several issues to the subject. In short, your magazine is way behind the times.

LAWRENCE W. LECHTRECK
Creve Coeur, Mo.

(Our reader has slightly overstated the case for the August TV Conversion Issue. Ten pages—10% of the 100-page magazine—were devoted to conversion in that issue. He has, however, equally understated the case for earlier numbers. True, we did not run any articles thirteen months before the one he complains about. In July, 1950, conversion was an extremely new thing, and *reliable* information about methods and pitfalls was nonexistent. As soon as a skilled operator had obtained enough experience in successful conversion, it was incorporated in an article, and published in January, 1951. At the same time, we offered information on big-tube conversion in brochure form and have since sent out several thousand brochures on the subject. Our main article (cover story) in May was also on conversions.

So far are we from believing that the subject is played out that we intend to continue printing articles on it whenever we feel that their excellence and originality merit publication. What do our TV technician readers think about it? Can you use more information on conversion problems?—*Editor*)



Suggested by: Arthur Henrikson, Chicago 5, Ill.

TV AIDS RETARDED

Dear Editor:

Your editorial in the September issue was inspired. As a matter of fact, television is already unintentionally adding to the education of retarded children who are forced by lack of school facilities to remain in their homes. Since they are shunned by their contemporaries, in many cases, the only contacts these backward children have are their parents.

As a secretary for the Association for the Help of Retarded Children, Inc., I have learned of several children who were able to recognize the alphabet and read the advertising because of its constant repetition. A case of one man's poison! Where television itself may be retarding to the average child because of its distracting influence when there is homework to be done, it is a broadening influence to the children who have no other instructors than their own mothers.

At the next opportunity you have to plug Television as an educational feature, please don't forget to mention the mentally retarded children at home as well as those in private and public schools.

CHARLOTTE P. DONNELLY
New York, N. Y.

(Television's inherent educational possibilities are so great that they show up in spite of the unfavorable environment of our present type of television programs.—*Editor*)

—end—

Book Reviews

ELECTRIC TRANSMISSION LINES, by Hugh Hildreth Skilling. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York, N. Y. 6 x 9 inches, 438 pages. Price $6.50.

This text is the result of a happy combination. The author has had years of college teaching experience. He has also consulted many practical specialists in the field. The result is a good book on theory, yet one practical enough for engineers and technicians. Algebra is used as well as circular and hyperbolic functions. There is a sprinkling of more advanced concepts.

The first half of the book deals with basic theory. The remainder is more specialized, with separate chapters on telephone lines, power lines, r.f. lines, filters, and wave guides. Diagrams and impedance charts add clarity.

Practical problems are given at the end of each chapter. They are chosen to explain and review chapter material. (We have encountered other texts with problems so complicated as to require a more advanced book to solve them.)

Wire characteristics, circular and hyperbolic functions are given in the appendix. Useful equations are printed on each inside cover.—*IQ*

SHORT WAVE WIRELESS COMMUNICATION (Fifth Edition), by A. W. Ladner and C. R. Stoner. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 5½ by 8½ inches, 717 pages. Price $8.00

This is the work of two British authorities on high frequencies. It is a comprehensive text on theory and principles. The discussions are largely non-mathematical, although equations and diagrams are provided. A high technical level is maintained.

In general the subject matter is well chosen, but there are a few exceptions. About 30 pages are devoted to properties of crystals and angle cuts. Only three pages are set aside for crystal circuits. The ratio detector is not mentioned at all. In view of the large number of circuits and components in the book, a more detailed index might have been advantageous.—*IQ*

TELEVISION ANTENNAS (Second Edition). Published by Howard W. Sams, Inc., 2201 E. 46th St., Indianapolis, Ind. 5¾ x 8½ inches, 223 pages. Price $2.00

Written with the needs of the practical technician in mind, this publication, containing 174 illustrations, presents an orderly treatment of TV antenna principles, construction, installation and reception problems. Simple computations and clear construction data, with radiation patterns and charts, are lucidly presented for a wide variety of TV antennas, from rhombics and conicals to multi-element Yagis.

Many commercial antennas are listed and described as to types and manufacturers.

The intensive coverage on installation techniques makes up to some extent for the somewhat skimpy treatment given to actual antenna and transmission line troubleshooting.—*CM*

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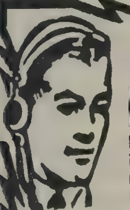

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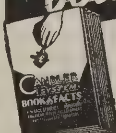

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ADVERTISING INDEX

RADIO SCHOOL DIRECTORY

Page 111

Radio-Electronics does not assume responsibility for any errors appearing in above index.

BASIC ELECTRON TUBES, by Donovan V. Geppert. Published by McGraw-Hill Book Co., Inc. 330 W. 42 St., New York, N.Y. 6½ x 9¼ inches, 332 pages. Price $5.00.

Designed for use in conjunction with electronics courses on a college level, this book covers the physical and electrical characteristics of basic types of vacuum and gas tubes. Higher mathematics, while desirable, is not absolutely necessary for an understanding of this readable book.

Full chapters are given to such industrial types of tubes as mercury-pool rectifiers and ignitrons. Thyratrons, glow-discharge tubes, and cathode-ray tubes also receive a chapter each.

Circuit theory is excluded to concentrate solely on tubes. The book is well indexed as well as being well illustrated.

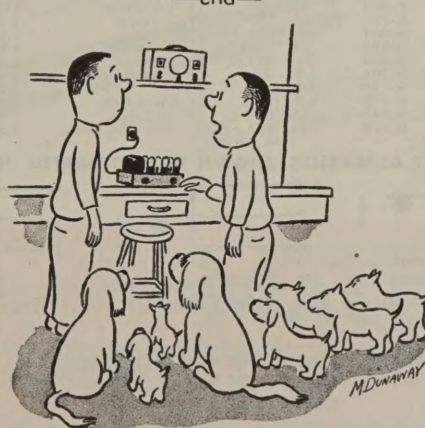
PRINCIPLES OF ELECTRICAL ENGINEERING. Fourth Edition, 1951, by William H. Timbie and Vannevar Bush. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York, N. Y. 6 x 8½ inches, 626 pages. Price $6.50.

This book will appeal to the more advanced student of electrical engineering. Advanced methods for analyzing electrical and magnetic problems are shown, including circuit analysis, the fundamental problems of electric and magnetic fields, and the relation of these problems to circuit analysis. The examples presented are developed from mathematical physics, the basis being the English, CGS and MKS unit systems.

The field covered is broad and includes: Kirchoff's laws; electric power and energy; simplification of electric networks; conductors and resistors; conduction in solids and liquids; transients in electric circuits; alternating-current circuits; the magnetic circuit; interaction between electric and magnetic fields; magnetic properties of iron and steel, and other subjects. Two closing chapters deal with electronics and electromagnetic waves.

A table of useful conversion factors is included, together with an index. To fully assimilate this book one should have a good mathematical background. —*HWS*

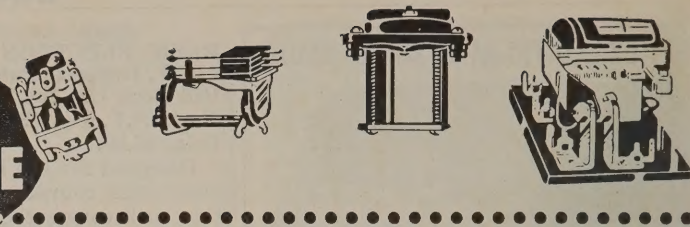
—end—



Suggested by: M. B. Dunaway, Omaha, Nebraska

"There must be a high frequency whistle in it somewhere."

RELAYS FOR EVERY PURPOSE



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R-806	115*	900	1A	$2.05
R-161	6	10	2B & 1A	1.10
R-518	85/125	6500	1C	3.60
R-633	180/350	10,000	1C & 5 Amps.	2.90
			Oct. Skt.	2.45
R-667	6	.75	1B/10 Amps. 1A/3 Amps.	1.45
R-632	6	12	5A & 1C	1.25
R-154	6/12	200	1A	1.50
R-517	12	250	2A	1.50
R-116	85	3000	1B	3.05
R-631	100/125	3300	2A	1.90
R-545	110/250	7000	1C	2.45
R-124	300	12,000	1A	1.55
R-160	6	12	3C & 3A	1.30
R-155	12	100	4A & 4B	1.45
R-520	200/300	14,000	2C	3.45
R-159	6	50	2A	1.35
R-153	12	200	1C & 1A	1.55

SHORT TELEPHONE RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-635	12	100	1C & 1A	$1.35
R-826	12	150	2C, 1B	1.55
R-770	24	150	1A/10 Amps.	1.45
R-771	24	200	1A/10 Amps.	1.45
R-603	18/24	400	2A	1.55
R-575	24	500	2C	2.40
R-764	48	1000	2C & 2A	2.00
R-563	60/120	7500	1A	1.70
R-801	115*	——	None	1.45
R-213	5/8*	——	2A	3.10
R-589	12	125	2A	1.30
R-113	12	150	4A	1.55
R-689	12/24	255	1C	1.55
R-799	24	500	None	1.00
R-115	24	500	1C	1.70
R-110	24/32	3500	1C	1.70
R-121	150	5000	2A & 1C	2.05
R-634	150/250	6000	1A & 1B	2.45
R-800	12	150	2C & 1A	1.55
R-537	12/24	150	2C & 1B	2.00
R-750	24	400	1A	1.60

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Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-650	24	100	1A/50 Amps.	$3.70
R-312	24	7	1A/200 Amps.	5.50
R-333	98/120	975	4A/Size 2	5.50
R-334	115	1200	3A/Size 2	5.50
R-338	6	7.5	1A/50 Amps.	3.45
R-353	65*	——	2A	3.95
R-358	18/29	200	1A/Dble. Brk.	2.00
R-445	14	12.5	1A/200 Amps.	4.05
R-446	12	18	1A/50 Amps.	3.90
R-447	12	18	1A/50 Amps.	3.90
R-448	24	67	1A/50 Amps.	3.90
R-449	28	160	1A/50 Amps.	3.90
R-450	24	75	1A/50 Amps.	3.90
R-188	24	200	1A/75 Amps.	3.70
R-183	24	60	1A/50 Amps.	3.45
R-187	24	100	1A/50 Amps.	3.70
R-554	24	85	2A/100 Amps.	5.90
R-788	100*	——	3B & 2A	5.45
R-682	115*	35	5A/10 Amps.	6.10
R-767	24*	20	2A/10 Amps.	4.95
R-180	12	25	1A/50 Amps.	4.05
R-265	24	60	1A/100 Amps.	3.45
R-535	24	70	1A/100 Amps.	4.80
R-556	24	70	1A/100 Amps.	4.80
R-557	24	100	1A/50 Amps.	3.85
R-178	24	100	1A/100 Amps.	4.80
R-608	24	125	1A/200 Amps.	2.80
R-184	28	50	1A/100 Amps.	4.90
R-719	24	10	1A/200 Amps.	4.95
R-182	28	80	1A/25 Amps.	2.40
R-244	75*	265	1A/20 Amps.	2.20
R-659	12	7.2	2A/20 Amps.	1.70
R-552	24	70	4A/50 Amps.	5.35
R-185	24	100	1A/50 Amps.	3.45
R-186	24	132	1A/50 Amps.	4.35
R-817	24	150	1A/50 Amps.	$3.45
R-534	14	45	1A/30 Amps.	2.05
R-223	28	150	1A/40 Amps./48 VDC.	1.70
R-680	6	3	1A/50 Amps.	3.90
R-677	6	3.5	1A/50 Amps.	3.90
R-532	6	15	1A/50 Amps.	3.90
R-676	12	16	1A/50 Amps. 1AUX/25A	3.90

ROTARY RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-712	24	200	2B	$2.05
R-711	24	200	2C & 1B	2.05
R-573	28	200	1C & 1B	2.05
R-766	24	230	12 Pos. 8 Deck	4.90
R-809	28	7	1B & 12 Pos. W/ 7″ Shaft for Wafers.	2.45

DIFFERENTIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-208	120	2000	2C/3 Amps.	$2.45
R-209	220/250	8000	1C/3 Amps.	3.10

SEALED RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-261	12/24	1900	1C/5 Pin Plug	$3.75
R-673	48/150	7500	1C/5 Amps.	2.80

VOLTAGE REGULATORS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-745	6	2	1A/10 Amps.	$1.05
R-780	24	350	1C/6 Amps.	1.05
R-509	6/12	35	1B/2 Amps.	1.05

SPECIAL RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-503	12/32	100	3A, 2C	$13.50
R-749	600	——	Max. 28 Amps.	7.45
R-804	550*	——	1B/38 Amps.	4.35
R-250	115*	——	Adj. Cir. Bk.-.04-.16A	17.50
R-579	220*	——	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	——	2C	6.10
R-246	115*	——	1B	11.20
R-246A	115*	——	1A	11.20
R-611	24*	——	1A /30 Amps.	5.35
R-283	12	125	1C/10 Amps.	4.35
R-614	18/24	60	1A/15 Amps.	4.35
R-245	12	25	4″ Micalex Lever	3.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	——	——	1A	3.50
R-669	75*	400 Cy.	1B, 1A	1.20
R-660	6	——	⅜″ Stroke	1.20
R-651	24	100	Solenoid Valve	3.10
R-295	12	275	Annunciator Drop	2.70
R-230	5/8	2	2A, 1C	2.70
R-813	12	12	Wafer	5.35
R-275	12	750	1A, 1B, 1C	3.45
R-716	24	70	2A/5 Amps.	1.80
R-620	6/12	35	2C, 1A	1.30
R-629	9/14	40	1C/10 Amps.	1.55
R-720	24	50	2C Ceramic	1.70
R-500	12	10/10	2C/6 Amps.	3.55
R-816	12	10/15	2C/6 Amps.	3.55
R-524	24**	——	————	1.20
R-566	115*	Coil Only		1.00
R-710	——	150 Coil Only		.75

KEYING RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-714	9/14	65	2C/5 Amps.	$1.55
R-850	12	450	1A/1.5 Amps.	1.50
R-721	18/21	290	2C/5 Amps.	1.55
R-694	24	300	1A/5 Amps.	1.50
R-935	28	1000	1C/1.5 Amps.	1.65
R-949	2.4*	60 Cy.	1A/5 Amps.	1.95
R-704	2/6	.25	2B/5 Amps.	1.35
R-173	2/6	2	1A	3.00
R-280	6/8	77	1A Dble. Brk.	2.45
R-647	6/12	15	1B/20 Amps.	1.45
R-273	20	160	2A/15A Dble. Brk.	3.55

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-169	24	200	1A	$2.45
R-570	24	230	1B Dble. Brk.	2.70
R-960	24	230	3C/15 Amps.	2.95
R-529	24/48	1020	2C	3.10
R-715	24	——	2 C Ceramic	3.70
R-584	6	20	1A Dble. Brk.	1.30
R-192	12	44	3C/10 Amps.	1.70
R-204	12	66	2A	1.45
R-224	12	85	1A	1.45
R-221	18/24	5000	1A	2.00
R-205	24	260	2C	1.55
R-891	24	475	1C/5 Amps.	1.45
R-536	27	230	2C	1.55
R-858	27.5	250	1A Dble. Brk.	1.45
R-833	6.5	1300	2C	3.05
R-220	75	5000	1C	1.50
R-828	6/8	42	1A	1.50
R-627	115*	——	1B Dble. Brk.	3.10
R-734	24	150	3C/10 Amps.	1.30
R-598	28	185	2C	1.30
R-622	20/30	200	3A & 2C/10 Amps.	1.45
R-274	24*	——	2A	1.55
R-855	110*60Cy	160	1A Dble. Brk/15A	3.25
R-277	12	30	2C-D Break Cera	2.20

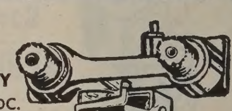
MIDGET RELAYS

Stock No.	D.C. Voltage	Ohmage	Contacts	Unit Price
R-572	24	256	1C	$1.25
R-857	24	260	1 Make Before Make	1.75
R-912	4/5	20	3A-1C Ceramic	2.50
R-291	6	5	1A	1.25
R-921	6.7	18	1A Dbl.Brk.@10 Amp.	1.45
R-738	12	60	3A	1.20
R-922	12	75	1A Dbl.Brk.@10 Amp.	1.45
R-144	12	228	1A	1.45
R-145	18/24	250	2A Ceramic	1.45
R-298	21	300	1A	1.25
R-296	21	300	1A	1.25
R-586	21	300	1A & 1C	1.25
R-137	24	300	1C	1.45
R-142	24	400	2C	1.50
R-785	24	200	2C/10 Amps.	2.00
R-607	24*	——	1A	1.20
R-606	24*	——	1A & 1B	1.20
R-605	24*	——	3A	1.20
R-728	6	30	1A	1.25
R-149	6/8	45	1B	1.50
R-732	12	120	1A	1.45
R-281	12	126	2A	1.25
R-818	18 24	300	1B	1.30
R-135	24	250	1B	1.45
R-133	24	300	None	.75
R-138	24	300	4A	1.45
R-132	24	300	2C	1.50
R-731	24	300	2C	1.55
R-292	24	350	1C	1.25
R-626	24	400	1A/5 Amps.	1.55
R-786	60	1300	2C	2.00
R-588	90/125	6500	4C	2.70
R-755	24	300	1A	1.45
R-150	6	30	1A	1.50
R-893	14	150	1A, 1C	2.50
R-895	14	150	2A, 1B, 1C	2.50

*AC. **AC/DC.

SPECIAL!

CO-AXIAL RELAY



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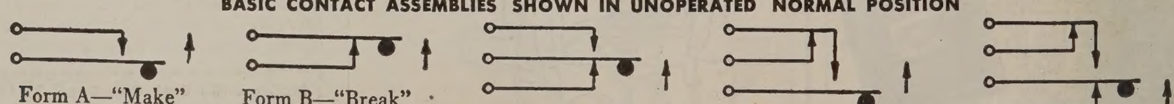

Form A—"Make" (Single Throw, Normally Open)

Form B—"Break" (Single-Throw, Normally Closed)

Form C—"Break-Make" (Double-Throw)

Form D—"Make-Before-Break"

Form E—"Break-Make-Before-Break"

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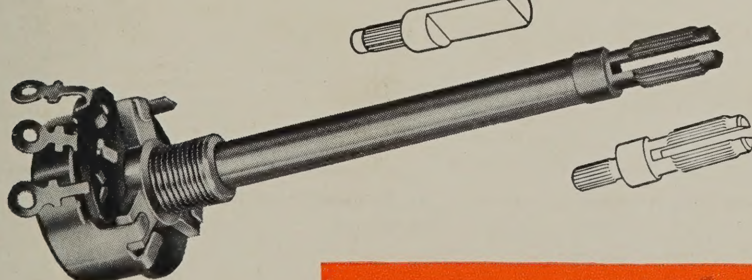

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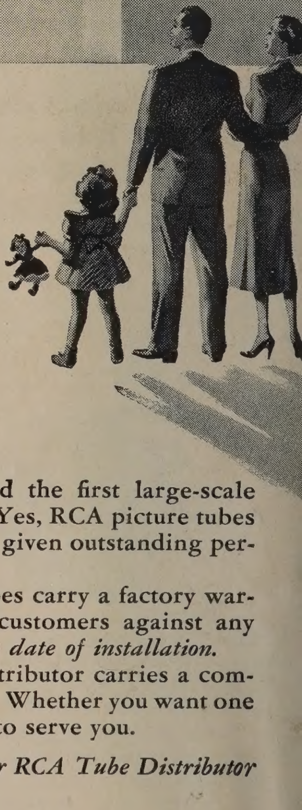

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